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ROYAL BOTANIC GARDENS, KEW.

BULLETIN

OF

MISCELLANEOUS INFORMATION.

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LII.—MINOR AGRICULTURAL INDUSTRIES.

III. FLAX (FIBRE AND SEED).

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For several centuries the flax plant, *Linum usitatissimum*, L., has been looked upon as one of the regular minor agricultural crops of certain parts of Great Britain, and, more particularly, of Ireland, where climatic conditions and marketing facilities are alike favourable. But the importance of the crop, more especially since the advent of machine-made cotton fabrics, and the introduction of cheap and rapid transport arrangements with other flax-producing countries, has been subject to considerable fluctuations; periods of activity and good prices being succeeded by years of unsatisfactory monetary returns, resulting in a diminished acreage; followed again by a cycle of years of increased prosperity and extended cultivation.

The area under cultivation in Ireland has varied considerably during the last 15 years, but has usually been between 34,000 and 50,000 acres. The United Kingdom on the other hand has shown a steady decline, and it is doubtful whether as many as 100 acres have been placed under flax during the last three years.

There are, however, signs that interest is reasserting itself in the subject. Prices of imported fibre have advanced considerably during late years; some of the foreign flax-producing countries are manufacturing more of their own fibre than hitherto; agricultural matters are engaging the critical attention of Parliament; the Development Commissioners have decided that the flax industry is worthy of encouragement in Great Britain, and assistance has been authorised to help forward certain experimental work, whilst the Department of Agriculture for Ireland are encouraging the cultivation of flax by experimental work, instruction, and a system of prizes for good cultivation and fibre preparation.

It is not, however, as a fibre plant alone that the flax is of value for almost as much importance attaches to its seed. The seed (linseed of commerce) is rich in oil, which is largely used in the preparation of paints, &c., whilst the residue is a valuable cattle food when prepared in the form of cake. Some countries grow flax almost entirely for the seed, others for both seed and fibre. Russia is the principal fibre-producing country, and her exports for 1912 were 311,806 tons of fibre, valued at £11,384,550. She also exported 36,403 tons of tow or inferior fibre, worth £901,481, and 161,419 tons of linseed, valued at £2,152,910.

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Before proceeding to consider the industry in the British Isles, it may be advisable to indicate, approximately, the extent of the world's production of flax, for fibre and seed, and the countries in which the crop is principally grown. Indications of these items are given in the "United States Year Book." The volume for 1911 has been used, and the year 1909 selected for special notice. In 1909 the amount of fibre was returned at about 618,140 tons from the principal fibre-producing countries, and the linseed crops for the same year at 100,943,000 bushels. The combined crops accounted for the cultivation of about 13,000,000 acres of land. These figures apply only to those countries which make regular returns.

The following extracts dealing with acreage, fibre, and linseed crops are taken from the above-named work. It must, however, be clearly understood that the acreage under cultivation cannot be accepted as a definite indication of the prospective crops of either fibre or seed, the yield being largely determined by climatic and cultural conditions.

Acreage under Flax (*Fibre and Seed*) 1908–1910.

—	1908.	1909.	1910.
North America—	Acres.	Acres.	Acres.
United States	2,679,000	2,083,100	2,467,000
Manitoba	23,400	22,400	24,600
Saskatchewan	110,000	110,300	438,000
Alberta	5,900	5,800	14,300
Total for N. America ...	2,818,300	2,221,600	2,943,900
South America—			
Argentina...	3,438,300	3,791,300	3,596,800
Uruguay	63,500	45,300	—
Total for S. America ...	3,501,800	3,836,600	—
Europe—			
Austria	123,700	111,100	95,900
Hungary proper	27,100	23,400	21,100
Croatia-Slavonia	17,500	—	—
Belgium	51,200	39,300	—
Bulgaria	300	400	900
France	70,600	50,500	53,600
Italy	—	—	4,400
Netherlands	35,600	24,800	29,000
Roumania...	44,900	30,100	33,100
Russia proper	3,250,900	3,120,200	—
Poland	87,500	90,600	—
Northern Caucasia	63,500	63,300	—
Sweden	4,500	4,200	—
United Kingdom (Ireland) ...	46,900	38,100	46,000
Total for Europe ...	3,824,200	3,596,000	—
Carried forward			

Acreage under Flax, 1908-1910—cont.

—	1908.	1909.	1910.
Brought forward ...			
Asia—	Acres.	Acres.	Acres.
British India including such native States as report.	2,099,400	2,997,000	3,194,600
Central Asia (four provinces only)	75,300	176,600	—
Siberia	111,700	128,800	—
Transcaucasia	—	22,900	—
Total for Asia	2,286,400	3,325,300	—
Africa—			
Algeria	1,000	—	—
Grand total	12,431,700	12,979,500	—

Flax Fibre produced in Europe and Asiatic-Russia, 1908-1910.

—	1908.	1909.	1910.
Europe—	Pounds.	Pounds.	Pounds.
Austria	74,106,000	68,136,000	50,191,000
Hungary proper	19,965,000	20,000,000	18,492,000
Croatia-Slavonia	8,861,000	9,000,000	8,000,000
Bosnia-Herzegovina	1,400,000	1,400,000	1,000,000
Belgium	27,000,000	27,000,000	28,000,000
Bulgaria	168,000	200,000	709,000
France	47,886,000	30,494,000	33,106,000
Italy	7,000,000	7,242,000	6,883,000
Netherlands	19,692,000	13,438,000	14,189,000
Roumania...	2,404,000	1,628,000	4,448,000
Russia proper	1,500,000,000	1,022,484,000	—
Poland	70,000,000	42,450,000	—
Northern Caucasia	26,000,000	26,130,000	—
Servia	1,032,000	1,100,000	1,100,000
Sweden	1,547,000	1,449,000	1,400,000
United Kingdom (Ireland) ...	17,745,000	16,081,000	19,882,000
Total for Europe ...	1,824,806,000	1,288,232,000	—
Asia—			
Central Asia	27,000,000	51,864,000	—
Siberia	45,785,000	38,109,000	—
Transcaucasia	10,000,000	6,429,000	—
Total for Asiatic Russia...	82,785,000	96,402,000	—
Grand total	1,907,591,000	1,384,634,000	—

Flax Seed (*Linseed Crops*) 1908–1910.

	1908.	1909.	1910.
North America—	Bushels.	Bushels.	Bushels.
United States	25,805,000	19,513,000	12,718,000
Manitoba	281,000	317,000	290,000
Saskatchewan	1,144,000	1,787,000	3,448,000
Alberta	74,000	109,000	64,000
Mexico	150,000	150,000	150,000
Total for N. America and Mexico.	27,454,000	21,876,000	16,670,000
South America—			
Argentina...	43,333,000	41,291,000	28,212,000
Uruguay	723,000	522,000	600,000
Total for S. America ...	44,056,000	41,813,000	28,612,000
Europe—			
Austria	932,000	852,000	663,000
Hungary proper	190,000	200,000	164,000
Croatia-Slavonia	30,000	30,000	30,000
Bosnia Herzegovina	4,000	4,000	4,000
Belgium	300,000	300,000	300,000
Bulgaria	2,000	2,000	8,000
France	722,000	436,000	416,000
Italy	—	281,000	232,000
Netherlands	341,000	219,000	316,000
Roumania...	180,000	205,000	363,000
Russia proper	17,326,000	19,767,000	—
Poland	903,000	948,000	—
Northern Caucasia	410,000	583,000	—
Sweden	22,000	21,000	—
Total for Europe ...	21,362,000	23,848,000	—
Asia—			
British India including such native states as report.	6,528,000	11,552,000	17,104,000
Central Asia	495,000	966,000	—
Siberia	797,000	771,000	—
Transcaucasia	150,000	107,000	—
Total for Asia	7,970,000	13,396,000	—
Africa—			
Algeria	8,000	10,000	10,000
Grand total	100,850,000	100,943,000	—

An idea of the requirements of certain countries may be gleaned from the fact that although the United States cultivates nearly 2½ millions of acres of flax annually for fibre or seeds, she imports between 7000 and 9000 tons of fibre each year to make good the deficiency in her requirements. Germany is credited with the

importation of two-thirds of her flax fibre, and Great Britain and Ireland require between 60,000 and 80,000 tons of fibre each year to keep their mills at work. In other words Great Britain is entirely dependent for her fibre on outside sources, whilst Ireland is only growing about one-fifth of the amount she uses. At the same time the fact has been amply proved in the past that both countries can produce fibre equal in quality to that produced by any other country. In addition to her imports of fibre, the United Kingdom is a customer to other countries for an amount of linseed which approaches annually the value of £4,500,000.

The following tables show the quantity and value of flax fibre and seed imported by the United Kingdom during the years 1909–1912, and 1908–1912 respectively. The imports of fibre and tow for the years 1909–11 are taken from the "Supplements to the Annual Statement of the Trade of the United Kingdom with Foreign Countries and British Possessions" for the years 1910–11, and the imports of fibre and tow for 1912, and linseed for the years 1908–12, from vol. i, of the same publication, for the year 1912 :—

Imports of Flax (dressed and undressed) for the years 1909–1912.

——	1909.	1910.	1911.	1912.	1909.	1910.	1911.	1912.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Russia ...	49,651	50,931	46,942	68,453	1,618,429	1,883,228	2,052,191	2,777,911
Germany ...	622	374	834	226	25,034	18,341	33,282	15,259
Netherlands	2,732	2,270	1,894	1,927	155,660	135,093	124,248	120,973
Belgium ...	19,070	15,453	12,137	16,205	1,303,408	1,133,906	1,054,288	1,421,529
France ...	298	165	296	252	15,713	8,039	13,025	12,587
Other Foreign Countries.	51	61	122	12	1,775	1,698	4,379	221
Total from Foreign Countries.	72,424	69,254	62,225	87,075	3,120,019	3,180,305	3,281,413	4,348,480

Imports of Tow or Codilla for the years 1909–1912.

——	1909.	1910.	1911.	1912.	1909.	1910.	1911.	1912.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Russia ...	12,360	11,140	11,450	12,366	333,287	328,189	382,648	415,990
Germany ...	229	523	713	384	5,920	15,848	22,186	16,533
Netherlands	219	366	175	95	5,514	9,737	4,920	2,631
Belgium ...	4,056	5,678	4,768	5,465	61,929	100,868	92,503	102,150
France ...	394	646	309	111	3,508	6,603	3,391	1,031
Other Foreign Countries.	90	77	215	273	1,977	2,516	3,528	3,572
Total from Foreign Countries.	17,348	18,430	17,648	18,694	412,135	463,761	509,176	541,907

Imports of Linseed for years 1908–1912.

——	1908.	1909.	1910.	1911.	1912.	1908.	1909.	1910.	1911.	1912.
	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	£	£	£	£	£
Russia ...	269,068	179,377	229,504	183,199	260,039	557,306	425,138	713,246	608,361	791,145
Germany ...	4,656	3,028	7,273	3,655	1,590	9,825	6,348	25,246	12,638	4,785
Netherlands ...	10,542	10,472	11,470	15,071	16,377	30,512	29,240	38,302	52,619	54,783
Belgium ...	13,016	7,097	4,788	1,228	975	28,693	15,792	14,365	4,746	3,871
France ...	1,650	19	1,038	43	2,362	3,372	43	3,268	147	9,148
Turkey, European.	967	1,623	14,242	2,658	3,285	2,066	4,139	50,874	9,339	10,761
Turkey, Asiatic	279	468	1,277	861	2,168	625	1,165	4,941	2,920	6,708
Morocco ...	2,721	3,318	4,737	16,795	12,089	6,335	7,965	14,364	55,358	37,569
China	—	—	—	607	30,561	—	—	—	2,121	95,594
United States of America.	71,488	35,293	22,643	1,217	47,578	154,486	86,558	59,528	4,363	123,075
Uruguay ...	24,692	12,862	308	1,995	7,370	50,409	26,721	895	6,900	23,120
Argentine Republic.	1,205,147	873,617	398,062	331,464	387,853	2,443,427	1,829,989	1,139,651	1,114,917	1,162,157
Other Foreign Countries.	6,571	4,090	1,150	1,882	4,551	14,138	8,571	3,281	6,109	12,864
Total from Foreign Countries.	1,610,797	1,130,764	696,492	560,675	776,798	3,301,194	2,441,669	2,065,961	1,880,538	2,335,580
British India ..	409,010	540,161	774,665	833,107	639,239	907,712	1,250,918	2,409,281	2,847,649	2,003,824
Canada ...	47,199	25,808	7,028	—	9,723	97,668	67,764	20,214	—	24,437
Other British Possessions.	189	695	74	92	759	440	1,840	262	349	2,358
Total from British Possessions.	456,398	566,664	781,767	833,199	649,721	1,005,820	1,320,522	2,429,757	2,847,998	2,030,619
Total ...	2,067,195	1,697,428	1,478,259	1,393,874	1,426,519	4,307,014	3,762,191	4,495,718	4,728,536	4,366,199

By a comparison of these figures it will be found that the value of flax has risen from about £43 1*s.* 10*d.* a ton in 1909 to nearly £50 a ton in 1912, the price in 1911 being £52 14*s.* 8*d.* per ton. During the same time tow, or short flax, has increased in value from about £23 15*s.* in 1909 to nearly £29 in 1912. This alone should prove an inducement for farmers to recommence the culture of flax.

The introduction of steam-driven machinery for the manufacture of linen led to the centralisation of that industry, and the cultivation of flax has gradually become similarly restricted, thus whilst the early years of last century saw the crop widely distributed in England and Ireland, the closing years found it confined almost entirely to Yorkshire, Lincolnshire and north-east Ireland. The principal centres of linen manufacture are Leeds, Dundee and Belfast, and the nearer the crop is grown to those places the greater should be the profit.

United Kingdom.—The flax-growing industry in the United Kingdom appears to have been in its most prosperous condition from the year 1863 to 1870. In the latter year the record crop of 23,957 acres was produced in Great Britain ; Ireland having reached her record of 301,693 acres in 1864. From 1870, however, the area under flax has steadily decreased, with now and then an improved year, until the present time. By 1879 Great Britain's crop was down to 7055 acres ; in 1880 it rose by about 1900 acres but two years later it dropped to 5220 acres. In 1895 the area

under flax was returned at 2000 acres; by 1902 the acreage was reduced to 824; in 1905, 437 acres were sown and a year later the crop was returned at only 263 acres.

Ireland has always grown more flax than Great Britain but her acreage indicates a similar shrinkage. In 1870 flax occupied 194,910 acres. By 1879 it was only grown upon 128,004 acres; 1880 witnessed an increase to 157,534 acres; by 1882 the acreage was down to 113,502. In 1895, 95,000 acres were sown; by 1898 the area under flax is said to have shrunk to 34,469 acres; by 1902 the acreage had risen to 49,742 and a somewhat similar acreage was recorded in 1910, but in 1909 the return showed only 38,116 acres under flax cultivation.

The area under cultivation cannot, however, be accepted as an accurate guide to the quantity of fibre produced as that is apt to vary considerably from year to year. Thus, in 1854, when Ireland grew 151,403 acres of flax she produced 35,606 tons of fibre, but in 1867 when 253,257 acres were placed under the crop, the yield of of fibre only amounted to 35,397 tons. Again in Ireland's record year of 1864 when the crop covered 301,693 acres, the yield of fibre was 64,506 tons, but the following year when the area under flax was reduced by about 50,000 acres, the yield was down to 39,561 tons. The greatest difference, however, is noticeable between the acreage and yield of the years 1855 and 1868. In the former year flax covered 97,075 acres and yielded 23,428 tons of fibre, whereas in the latter year 206,483 acres only yielded 24,987 tons of fibre. The yield of fibre from the best seed is said to vary on well cultivated land from 5 cwt. to 10 cwt. an acre, but the latter quantity is rarely reached.

Although the production of fibre has diminished in Ireland to such a serious extent during the last 40 years, the linen industry has increased enormously during the same period. According to an article which appeared in the "Journal of the Society of Arts," March 4th, 1910, p. 424, there were 650,774 spinning spindles in Ireland in 1864, but in 1908 the number was 913,423 and of doubling spindles, 18,254. Power looms are said to have been introduced in 1850. In 1864 there were 8187 in Ireland, whilst in 1908 the number had risen to 35,386.

The weak condition of the flax industry in the United Kingdom has occupied the attention of Parliament and leading agriculturists during late years. In December, 1909, a Departmental Committee was appointed to enquire into the present state of the flax-growing industry in Ireland and the causes contributing to its decline, and to submit recommendations. The result was published in a Parliamentary Paper [Cd. 5502]. Amongst other results a scheme of apprenticeships in the cultivation and handling of flax was instituted by the Department of Agriculture and Technical Instruction for Ireland in 1911. This is described as follows in the Department's Journal for 1911–12, vol. xii., p. 156.

"The Department have made arrangements for the training, as apprentices to the flax-growing industry, of a limited number of young men who desire to become qualified for the position of Flax Instructor. Apprenticeship will extend over a period of about twelve months.

"The apprentices will receive instruction and must take part in all operations connected with the cultivation, retting, and scutching of flax, and with the marketing of the fibre. They will be required to devote their whole time to such work.

"Applicants for apprenticeships must be at least 21 years of age, in good health, and of strong constitution.

"The apprenticeships will be awarded on the result of an examination, which will include written tests in English and arithmetic. Each candidate will also be examined orally as to his knowledge of flax-growing, and his general suitability for an apprenticeship. Preference will be given to those who have attended Winter Agricultural Classes. No expenses will be allowed to candidates in connection with their attendance at this examination.

"Successful candidates will be called up for taining about the beginning of October. They will receive wages at the rate of fifteen shillings per week from the date of their commencing work, and will be required to find their own board and lodging. The apprenticeship may be determined at any time by one week's notice in writing on either side.

"While it is probable that apprentices who complete their training satisfactorily will be offered appoinments as instructors, at a salary of about two pounds per week, the Department do not undertake to procure employment for any apprentice on the conclusion of his training."

In the same volume, pp. 397–399, a scheme of prizes for the guidance of county committees is outlined for the encouragement of the culture of flax and the preparation of its fibre. The scheme is divided into two sections. Section A refers to exhibitions of flax; prizes being offered for growers, scutchers, other employees and mill-owners. Section B is subdivided as follows:—

(*a.*) For growers, the valuation of whose holding does not exceed £10, and who grow at least half a statute acre of flax, or sow at least ¼ bag of seed.

(*b.*) For growers, the valuation of whose holding exceeds £10 but does not exceed £25, and who grow at least one statute acre of flax or sow at least 1 bag of seed.

(*d.*) For growers, the valuation of whose holding exceeds £50, and who grow at least three statute acres of flax, or sow at least 1½ bags of seed.

It is stipulated that judges shall take into consideration freedom of crop from weeds; uniformity of crop; length and quality of crop.

Since 1901, the Department have been conducting experiments in manuring, the use of various types of seed, and several other important questions. The results of these experiments have been published from time to time in the Department's Journal, notably in vols. ii, pp. 636–653; iii, pp. 663–681; iv, pp. 616–635; v, pp. 449–464; vii, pp. 250–268; viii, pp. 423–440; ix, pp. 270–284; x, pp. 279–293; xi, pp. 327–341; xii, pp. 502–517.

From manurial experiments conducted during the years 1905–08, the following conclusions were arrived at (vol. xii, p. 502):—

"(1.) Of the potash manures in general use Kainit and Muriate of Potash are the most suitable for flax, either of these manures

being preferable to Sulphate of Potash, and that corresponding dressings of Kainit and Muriate of Potash give much the same increase in yield.

"(2.) Kainit or Muriate of Potash may be applied either in autumn or at sowing time with equally good results.

"(3.) The results from a combination of Kainit and a slow-acting nitrogenous manure, such as rape meal, although in some seasons satisfactory, were too irregular to warrant the general adoption of this mixture as a manure for flax in preference to dressings of Kainit or Muriate of Potash now so generally applied."

From the 1910 experiments it was found that a dressing of Muriate of Potash at the rate of 1 cwt. to the statute acre resulted in an estimated profit of £2 0*s.* 10*d.* per acre over unmanured ground. When 1 cwt. of Muriate of Potash and ¼ cwt. of Sulphate of Ammonia was used, the profit was estimated at £2 16*s.* 9*d.* a statute acre, and £2 17*s.* 8*d.* a statute acre when 1 cwt. of Muriate of Potash and ½ cwt. of Sulphate of Ammonia was applied. When, however, 1 cwt. of Muriate of Potash, ¼ cwt. of Sulphate of Ammonia, and 2 cwt. of Steamed Bone Flour was used there was an estimated *loss* per statute acre over unmanured land of £1 8*s.* 3*d.*

The experiments indicate that Muriate of Potash and Sulphate of Ammonia in the proportion of two parts of the former to one of the latter is a suitable manure for flax, but that phosphates, whether in the form of bone meal or other guise, are unsuitable. Their unsuitability is chiefly due to their tendency to encourage weeds. The full results of the experiments for 1910 will be found in vol. xii., pp. 502–507.

The flax seed tests tend to show that quality of seed only can be relied upon to settle the question as to whether it is better to sow Riga or Dutch seed. Some years one country produces the best seed, and other years the other country. Seed from both countries, however, is likely to produce a heavier crop of fibre than Irish seed, though trials relating to this side of the question are still in progress. Seed from selected plants is said to exert a distinct influence upon fibre yield, and also upon quality. Intending planters are advised to procure the leaflet on Flax Seed (No. 29), which is revised annually in order that it may afford a guide to the best country from which to obtain seed. Planters are also advised to test the quality of their seed before making a general sowing.

With regard to Great Britain the Development Commissioners are taking an active interest in the condition of the flax industry and on their behalf a considerable amount of first hand information has been collected in the chief flax-growing countries of Europe, *i.e.*, Russia, Holland, Belgium, France, Ireland, Austria-Hungary, and Germany. Last year experiments were conducted in Bedfordshire both in growing and retting, and this year the assistance of Leeds University has been enlisted in conjunction with a Flax Growers' Association, formed last year, in carrying out experiments in flax cultivation.

A considerable amount of information collected in the above-mentioned countries, together with notes on the history of flax in Great Britain is given in an interesting article entitled "The Projected Revival of the Flax Industry in England," by J. Vargas

Eyre, Ph.D., which appeared in "Science Progress," No. 28, April 1913, pp. 596–628. Dr. Eyre explains the fluctuations which have occurred from time to time in the acreage under flax as being due largely to the price of wheat. When wheat and flax show a small margin of difference in profit per acre, then flax is dropped in preference for wheat but when wheat is cheap and flax commands a good price greater attention is paid to flax. In discussing the crop he says: "The result of the enquiry made on behalf of the Development Commissioners leaves no room for doubt that the climate is well suited to flax. The crop makes no special demand for a particular class of soil, so long as the land is properly prepared and suitably manured. Light loam, however, may be said to be most favourable and chalk least favourable to a fibre crop. Large areas of suitable land are to be found in Yorkshire and Somersetshire, as well as in the midland and eastern counties. Flax can be grown successfully as a fibre crop in this country and at the same time the seed which it bears can be profitably saved; indeed, this is the practice which was formerly adopted. The flax crop is somewhat more troublesome than the usual farm crops but no difficulty in its cultivation need be apprehended provided practical information be placed at the disposal of farmers. This could be done easily and there is every reason to believe that good crops of flax would again be raised here if attention were given to the work." With regard to retting, the author suggests that small retting depôts should be established out of public funds each one capable of dealing with the produce of 100 acres. Such retteries would doubtless be of the greatest benefit to growers and would go far towards re-establishing the industry, for the retting process in the past has been the chief stumbling-block to many growers.

Referring to the agricultural requirements of flax the author has arrived at the conclusion that good flax can be grown on a great variety of soils, providing their texture be suitable. Very heavy clay is not recommended, neither is chalk, whilst soil rich in humus and peaty moorland are also undesirable. Any other clean land, however, which is capable of producing good grain is likely to produce good flax.

With reference to seed it is said that all countries look to Russia for the principal supply. The seed is procured from the Baltic Provinces by way of Riga. It is then grown in other countries for about three seasons, giving rise to crops bearing seed which is known respectively as "Riga-Child" and "Riga-Grandchild." Where the climate is moist and dull, original Russian seed gives the best results, especially if the soil is light. Where the prevailing atmospheric conditions are dry, or the soil is somewhat heavy, better results are obtained by using "Child" seed although the results are less uniform than those from Russian seed. "Dutch-Riga-Child" seed is said to be highly favoured for sowing in Holland, Belgium, Ireland and France. It is added that "by long experience merchants have found that seed from a region where there are certain conditions of climate, is better suited for exportation to one country than to another; for example, seed from a very wet district does better in the drier climate of Holland than in

Ireland, whilst seed from a drier region is better suited to the damp climate of the north of Ireland."

In addition to the article in question, elaborate cultural details are to be found in the "Journal of the Royal Agricultural Society," 2nd series, vol. i, (1865), pp. 181–204, in articles by the Rev. Nathaniel M. Brown, Mr. P. H. Frere and Mr. H. Wells; in "British Manufacturing Industries" (1876), pp. 52–63, and pp. 64–108, on the manufacture of linen, both articles by Mr. W. T. Charley; and in "Spon's Encyclopaedia of the Industrial Arts," pp. 964–978. From these articles the following cultural instructions are taken.

It is a well known fact that flax may only be grown successfully on a long rotation system, for although it rarely occupies the ground for more than 13 weeks, it extracts a considerable amount of food material from the soil. It is equally clear that the best results can only be procured when the seed is sown on land free from coarse weed seeds. Therefore, the same plot of land is only cropped with flax at intervals of from 7 to 10 years and crops immediately preceding flax are selected to a certain extent by reason of their ground-cleaning qualities. Wheat or oats, preferably the latter, are often chosen. Deep autumn ploughing is usually recommended both on heavy and light land, to be followed in the former case by a second ploughing in spring. When light land is ploughed a second time, it is stated that it should not be turned up more than 4 inches in depth in order that the bottom may remain firm. The land must subsequently be well harrowed in order to provide a fine and even surface and is then sometimes lightly rolled. Farmyard manure is not given immediately before a flax crop on account of its liability to lie in patches and thereby encourage unequal growth, but chemical manures may be applied either with the autumn ploughing or with the spring working of the ground.

Seed sowing usually takes place between the beginning of April and the end of the first week in May according to weather conditions, and immediately follows the harrowing and rolling of the ground. Even sowing is essential to success, for if the crop is patchy, the fibre varies considerably in quality. When grown strictly for fibre close sowing is necessary, for the most suitable plants are those with single stems, but when a seed crop is desired, the seed is sown thinly to allow the plants to branch. The amount of seed used per statute acre for fibre production depends entirely upon its vegetative qualities, but usually from 2 to 2½ bushels. On heavy land rolling is often dispensed with before sowing the seed. After sowing, the ground is lightly harrowed and sometimes rolled. When the young plants are a few inches high it is usual to go over and weed the ground. The work-people require to exercise great care in order to cause as little injury as possible to the flax, and for this reason, they work against the wind in order that the wind may assist the bent over plants to resume their erect habit.

When the crop is grown solely for fibre, harvesting is commenced as soon as the lower parts of the stems assume a yellowish hue but if seed is required, harvesting is not commenced until the seed is mature. In the former case the fibre is of superior quality. Harvesting is carried on by pulling the plants up, instead of mowing

them down, as is done with a corn crop, for the reason that however carefully the crop may be cut a certain amount of fibre will be lost. By pulling, it is also possible to keep the flax free from weeds and to keep the plants straight. When the whole crop is of a similar length harvesting is easier than when it varies, for in the latter case it is necessary to keep the various lengths together as much as possible. As the plants are pulled, the soil is knocked from the roots and they are laid in small heaps to be afterwards tied in bundles, care being taken to keep the stems whole and the fibre unblemished.

In some cases the straw is retted almost at once but in other cases it is stacked after drying and kept for some considerable time before being placed in the retting pools. In either case the seed pods are removed first either by rippling or by threshing. The first method is said to cause the least harm to the straw. It consists of drawing the upper part of the straw through an iron comb placed horizontally over a large sheet or tarpaulin when the work is carried on in the field, or over a clean barn floor when conducted indoors. Threshing is carried out by spreading the flax on hard floors and beating the heads with mallets. The former method is, however, considered the better as the flax can be kept straighter and cleaned of impurities during the process.

The first operation in the separation of the fibre from the straw is known as retting. This is sometimes accomplished by spreading the straw thinly, in straight lines, over grass fields and leaving it to the action of the weather until the fibre can be easily detached from the waste material. Even when the greatest care is exercised, however, it is a somewhat unsatisfactory method, and preference is usually given to water-retting. This may be accomplished in several ways. A system of pools or tanks, in which the depth is sufficient to allow of the plants being covered with water when almost upright, may be arranged within easy access of a river; crates sunk in a river may be used; a backwater of a river or a deep ditch may be requisitioned; or the retting may take place in heated tanks. The flax is placed loosely in tank or crate in regular rows with the roots sloping slightly downwards. When filled, a layer of rushes or straw is placed over the flax and on this, tough turves and stones are placed to weight down the flax. Fermentation is set up, which is allowed to continue until the fibre separates readily from the wood. The flax is then lifted out of the water and is spread over grass or stubble fields to dry. If the water be drawn off before the flax is removed from the tanks a certain amount of sediment is said to settle on the fibre and cause injury. The time required for retting depends on the weather, a shorter period being necessary in warm than in cold weather. From 7 to 14 days is about the normal time required. Warm water retting is conducted in specially constructed tanks, and the work is accomplished in about 3 days.

Further particulars regarding rippling and the subsequent processes of grassing, lifting, scutching, &c., may be obtained in the articles already referred to, but it is unlikely that the average agriculturist will be prepared to undertake such duties which could be carried on more economically at recognised centres, under the inspection of fibre experts.

Regarding the cost of production, Dr. Eyre remarks that it is now so long since flax was grown as a field crop in this country, that little importance can be attached to the recorded cost of production. Fifteen years ago the estimated cost of this crop in Cambridgeshire, Lincolnshire and Suffolk was said to be about £5 per acre; in Yorkshire a trifle less, and in the south of England more. It is probable, however, that these figures would now be exceeded. It would appear that only by a series of extensive trials can it be ascertained whether the crop is likely to prove remunerative in Great Britain.

With respect to flax-growing in other countries, Dr. Eyre deals exhaustively with Europe, and a very good article entitled "Cultivation, Preparation and Production of Flax and Linseed," appeared in the "Bulletin of the Imperial Institute," vol. ix, 1911, pp. 355–380. Use has been made of this article in some of the succeeding notes.

United States of America.—The position of the flax crop both as regards fibre and seed production is dealt with by Mr. L. H. Bailey, in the "Cyclopedia of American Agriculture," vol. ii, pp. 293–302, and by Mr. C. R. Dodge in the following Reports issued by the U. S. Department of Agriculture. "A Report on Flax Culture for Seed and Fibre in Europe and America," pp. 1–80; "A Report on Flax Culture for Fibre in the United States," pp. 1–87; "A Report on Flax, Hemp, Ramie and Jute," pp. 43–63; "Useful Fibre Plants of the World," Report No. 9, pp. 219–228. The centre of the industry in the United States is found in Minnesota and the two Dakotas, about 90 per cent. of the whole production being in these States. In 1905, North Dakota grew 1,357,171 acres of flax and produced 15,743,184 bushels of seed, and in the same year Minnesota produced 449,008 acres of flax and 5,073,790 bushels of seed. Fibre production was neglected to a considerable extent during the latter half of last century, but a considerable amount of attention has been paid to this branch of the crop during the last 15 or 20 years, and a great deal of experimental work has been carried out in Minnesota with a view to producing high yielding strains of seed and of discovering the most economical methods of culture.

Cultural operations are conducted on somewhat similar lines to those in force in Europe, but the crop is usually cut instead of being pulled. Good crops are said to be produced on virgin land containing lime, and when grown as one in a sequence of crops, the rotation is somewhat as follows:—Clover, flax, corn, oats, clover, wheat, corn, oats, clover, flax. In many parts a combination of seed and fibre crop is recommended on account of the high price of labour.

Canada.—Flax has long been grown in certain parts of Canada as a seed crop, but of late years attention has also been directed to its fibre. In the "Journal of the Society of Arts" for June 3rd, 1910, p. 692, flax in Canada is referred to as follows:—"There is certainly a future for flax in Canada if the recent discovery of a process of treating the straw for textile purposes turns out satisfactorily. At present flax is grown in Canada for its seed, the linseed of commerce, alone, and yields from 10 to 16 bushels per acre, at a value of 5*s*. a bushel. The cost of cultivation is about 30*s*. per acre.

While this affords a fair margin of profit, the value of this industry will be greatly enhanced if the process referred to results in the manufacture of tow from the stalks, as the straw averages 1½ tons to the acre, which would yield about 25 per cent. of tow. The refuse also can be used for paper-making." Apparently, in the same year, however, the fibre was a recognised asset, for the "Bulletin of the Imperial Institute," vol. ix, 1911, p. 378, records the fact that 439 tons of fibre, valued at £17,509 were exported to the United States in 1910, and a year previously 594 tons of fibre, worth £29,120, were exported to the same country.

The position of flax in Canada is, however, clearly indicated in Bulletin 59, "The Flax Plant; its cultivation for Seed and Fibre," pp. 1–13, of the Central Experimental Farm, Ottawa. It is there definitely stated that flax has been grown for its fibre in some parts of western Ontario for many years. It is most widely grown for its seed in Manitoba, Saskatchewan, and Alberta. In 1906, Saskatchewan, with the largest acreage of 108,834 acres, produced 1,504,814 bushels of seed. The produce of the same region in 1910 was 3,044,138 bushels. Experiments are now being conducted at various Dominion Experimental Farms, with a view to securing types of plants yielding heavy crops of fibre and seed, and of discovering improved and more economic methods of handling than already exist. The conclusion appears to have been arrived at that Manitoba and Ontario seed produces a heavier crop of seed than that imported from Russia and Holland. The heaviest yielding kind, however, is one raised in Minnesota, and named Minnesota No. 25. In carefully conducted experiments this has been found to yield 32·9 bushels of seed per acre, the next highest being Manitoba seed with 30 bushels per acre.

A series of experiments were conducted in 1896 for the purpose of ascertaining the most satisfactory regions for fibre production, the result being Nappan, Ottawa, and Agassiz. The heaviest yield of pulled flax was at Ottawa, where 7,878 lbs. per acre were obtained, and where the seed had been sown at the rate of 80 lbs. per acre.

India.—An exhaustive account of the cultivation of flax in India is given by Sir G. Watt in his work on "The Commercial Products of India," pp. 719–731. The plant is grown there more for the sake of its seed than for its fibre, although interest in fibre production is apparently on the increase. In the years 1906–7 the acreage of land carrying a pure flax or linseed crop was returned at 3,028,200 acres, whilst 633,000 acres were sown with a mixed crop of linseed and other oil-producing seeds.

The chief centre of the industry, as given by Sir G. Watt, is Bengal, followed closely by the Central Provinces and Berar. Then come the United Provinces; Bombay and Sind; Panjáb; Hyderabad, Central India and Rajputana; Madras, Assam and Burma. The amount grown in some of these regions is, however, of comparatively little importance. The following details are taken from p. 726 of the above-mentioned work:—"It is thus a crop that may be spoken of as produced most abundantly within the indigo districts. At all events it is mainly grown, so far as Bengal is concerned, in Tirhut and Bihar. Mukerji (Handbook Ind. Agrc.,

pp. 272–4), says it is believed to love well-drained heavy, loamy soils, especially if rich in lime, such as those often under mustard or til crops. It requires more or less the same soil, in fact, as wheat and gram. The land should be prepared in September, and thorough and deep ploughing is desirable. Before the close of the monsoons the sowings are usually completed. The seed rate has been given as 8 to 12 lb. to the acre. If sown late, irrigation may be necessary, but when the plant is in flower rainfall is injurious. The crop is harvested by the end of February, or the beginning of March, and the seed extracted by flailing. Six to eight maunds of seed (say 500 to 700 lb.) is the average produce per acre. The straw is useless as fodder, and indeed it is even said that green plants eaten by cattle have been known to prove fatal. The seed is held to yield one-fourth of its own weight of oil."

An interesting account of the "Culture of Flax in India" is to be found in "The Fibrous Plants of India," by Dr. Forbes Royle, pp. 135–232. This was published in 1855, and gives a detailed account of the condition of the crop at that period.

Argentina and Uruguay.—The production of linseed is an important industry in these countries, and there is a considerable trade in seed with the British Isles. Until recently flax was grown entirely as a seed crop, but of late some attention has been turned to fibre. Between 30,000,000 and 40,000,000 bushels of seed is the annual output of these countries.

Australia.—Attention has been given to both linseed and fibre production in New South Wales, Victoria, Queensland, and South Australia, but so far neither crop can be said to be of any particular importance. Articles on the position of the crops in Victoria are to be found in the Journal of the Agricultural Department, Victoria, April 1906, p. 211, and May 1906, pp. 298–308.

Other references to flax in Australia are given in the Journal of Agriculture, South Australia, January 1st 1904, p. 370, and the same journal for September 1908, p. 189.

The Bulletin of the Imperial Institute, vol. ix., 1911, p. 370, records the receipt of a sample of seed grown in Anglo-Egyptian Sudan, which was valued by experts at 47*s.* 6*d.* per quarter if marketed in limited quantities, and at about 44*s.* 0*d.* per quarter if imported in large supplies. (May 1906.)

British East Africa.—During the last few years experiments in flax culture have been conducted at several Agricultural Experimental Stations and Mission Centres in British East Africa, more for the sake of the seed than the fibre, however. In the event of flax proving a suitable crop for the country it is more than likely that the fibre will be given consideration likewise. The following extracts taken from the "Annual Report of the Department of Agriculture, British East Africa," for 1911–1912, give an idea of the position up to date. On page 77, Mr. H. Powell, General Manager of the Kabete Experimental Farm, writes :—"Four acres of linseed, Riga variety, were sown on 1st May, 1911, and harvested on 12th September. It yielded 588 lbs. per acre. This crop continues to do well here. Ten acres were sown on the 21st November and cut on the 22nd March 1912 ; the yield was

319 lbs. per acre. About the middle of January the crop was completely eaten off by caterpillars, but the heavy rains in February enabled the crop, which at one time was on the point of being ploughed up, to recover. The prevalent wet weather during April retarded threshing and the yield was really in excess of the figure given."

Regarding its culture at the Government Experimental Farm, Kibos, Mr. H. H. Holder, Plant Instructor, wrote on June 25th 1912 (*see* p. 100):—"Linseed.—The success which attended the trials made by the Rev. Father Witlox, of the Roman Catholic Mission at Kakamega, two years ago, and also those by certain headmen and natives there, led to a series of experiments being started at Kibos with two varieties, introduced by the Chief of the Economic Plant Division from Ceylon, and two Russian varieties from the Kabete Experimental Farm, Nairobi. The Ceylon varieties which consist of one brown and one white are lower growing in habit and produce a considerably larger sized seed than that of the Russian varieties. The trials were conducted with a view to testing their bearing qualities. Accordingly four plots were laid down on the same ground as follows:—

"Two plots, two acres each in size, were sown broadcast with the Russian varieties, and two plots, one acre each, sown in drills with the Ceylon varieties.

"All the varieties made fairly good growth at first, but the Ceylon varieties appeared to have withstood the dry spell in June much better.

"Although the climatic conditions at Kibos are not considered to be altogether ideal for linseed cultivation, it might be premature to ascribe the cause for the poor results obtained with this first trial to this alone, as planting was carried out rather late in the season. Indeed, judging by the rapid spurt of the Ceylon varieties made after every shower of rain which occurred when the plants were in the field, it appears safe to believe that, planted at the commencement of the rains in March or April on a well-drained and thoroughly prepared soil, the crop may be cultivated with equal success here as at Kakamega.

"Besides the native trials at Kakamega, a plot was planted at Sagam which did equally well under Headman Obonyo.

"Perhaps none of the other introduced crops have taken on so rapidly amongst the natives and there seems every prospect of its cultivation becoming in a short time thoroughly established throughout a large portion of the Nyanza Province."

A report on various samples of fibre received from this region is given in the Bulletin of the Imperial Institute, vol. ix, 1911, pp. 11–14. The best sample received from the Government Experimental Farm at Kabete was valued in July 1910, at £30 per ton.

From this country a sample of seed was received at the Imperial Institute in 1905, which was valued at 40*s.* 0*d.* to 42*s.* 6*d.* per quarter.

In 1908 a sample was received from Natal which was valued at £11 per ton if delivered in small lots of 50 to 100 tons, or at £10 10*s.* per ton if imported in quantities of 500 to 1000 tons.

An abstract of a paper on "The Growing of Linseed as a Farm Crop," which was read before the Agricultural Section at the recent meeting of the British Association, by Mr. Duncan Davidson, appeared in the "Journal of the Royal Society of Arts," Sept. 26 1913, pp. 984–985. The object of the paper was the encouragement of linseed culture by farmers as a food substance for cattle. The author urged the special value of linseed as a cream substitute for calves, its superiority as a fattening and finishing food for older cattle, its ability to secure good condition in horses, its unrivalled effect as a tonic for ailing stock, not to mention its excellence for sheep as reasons for its culture. He discussed the increasing demand for linseed oil and the advanced price of linseed and cake which almost prohibit their use as stock foods. He further claimed that experiments go far to prove that 10 to 15 cwt. of linseed can be grown at a cost of about £6 per acre on medium land whilst £10 is paid for half a ton of linseed meal containing up to 10 per cent. of cheaper meal. He gave the cost of production on a well-managed farm of medium land at from £6 to £7 per acre and said that a yield of 20 to 30 bushels of grain and 25 to 35 cwt. of straw might be expected if a suitable kind of seed were sown. Full details of cultivation were given. For seed growing the author recommended sowing from 1½ to 2 bushels of seed per acre (the seed weighing about 56 lbs to the bushel) more seed being necessary for a fibre crop alone.

Diseases of Flax.—A few diseases are rather troublesome at times. The worst is possibly that known by the name of "Flax wilt." It is prevalent in France, Holland, Belgium, Ireland, the United States, &c., but according to Massee, "Diseases of Cultivated Plants and Trees," p. 495, it is uncommon in Russia. It is due to the presence of a fungus (*Fusarium lini*, Boll.), and affected plants may be detected by the manner in which they suddenly wilt or fall over and die. The only possible remedy appears to be continual change of ground for the crop and this is probably one reason why flax is only successfully grown in many countries by a long rotation system. Flax rust (*Melampsora lini*, DC.), is another fungus disease which sometimes causes trouble. Its presence may be noted by orange-coloured spots on the leaves, &c. Mr. Massee refers to it on p. 326 of the previously-mentioned work. Wireworms sometimes cause trouble, more especially when a flax crop is grown upon newly broken up grass land. There are also certain caterpillars which may cause injury.

In conclusion it would appear that the present position of the flax industry is such as to warrant an extended series of trials of the cultivation of flax both for fibre and seed with the object of ascertaining the suitability of flax as a regular farm crop, in places where it is not already grown. The farmer has little to lose through such trials and much to gain. In places where the summer is not sufficiently long, or warm enough, to mature a corn crop it seems quite likely that flax would succeed, since the harvesting of the crop is not so dependent upon weather conditions as it is for wheat or oats whilst flax occupies the ground for a much shorter time.

LIII.—ACANTHUS PUBESCENS AND A. ARBOREUS.

W. B. Turrill.

The Tropical African *Acanthaceae* were worked out by the late Mr. C. B. Clarke and published in the *Flora of Tropical Africa* in 1899–1900. On p. 106 of vol. v. of this work he describes *Acanthus arboreus*, Forskal, and reduces as synonymous with it the species *A. polystachyus*, Delile, *A. pubescens*, Engler, and *A. Gaëd*, Lindau, and the variety *pubescens*, T. Thoms., of *A. arboreus*. In naming the *Acanthaceae* of the Kässner Expedition, 1908, it was found that a revision of the synonyms given under and of the characters given for *A. arboreus*, Forsk., in the flora was necessary. The results of the investigation are recorded below.

The degree of hairiness in *A. pubescens*, Engl., and the allied species is not to be relied upon as a specific or even varietal character, but characters which are constant and in accordance with geographical distribution are to be found in the sepals. Before giving the results obtained by the use of these characters it will be well to give a brief historical resumé of the species and their synonyms under discussion. *A. arboreus* was described by Forskal from specimens collected in Arabia. The description is meagre but sufficient to show that *A. pubescens*, Engl., was not the plant meant. The name *A. arboreus* is the name generally accepted for the Abyssinian and Somaliland plant as well as for the Arabian plant. At Kew there is only one specimen (*Schweinfurth* 1112) collected in Arabia and this has only an imperfect calyx. If, however, the Arabian and Abyssinian plants prove to be different the latter must bear the name *A. polystachyus*, Delile, and the name *A. arboreus*, Forsk., must be retained for the former. Thanks to the good figure and description given by Delile (Cent. Pl. Afr. 62, t. 1, fig. 2), there can be no doubt as to the identity of his *A. polystachyus* with the common Abyssinian and Somaliland plant at present bearing the name *A. arboreus*, Forsk.

A form of *A. arboreus*, Forsk., has been described by Lindau from Somaliland as *A. Gaëd.* The type specimen, *Hildebrandt* 1399, is at Kew and appears to differ from typical *A. arboreus*, Forsk., only in having smaller flowers. *Acanthus arboreus*, Forsk., var. *pubescens* is first used (as a nomen nudum) in Speke's Nile Journey, Appendix, p. 643. It was shortly described by Oliver in Trans. Linn. Soc., vol. xxix., p. 129. The specimen on which this variety was founded, namely, *Speke and Grant* 136, must be taken as the type of *A. pubescens*, Engler, though that author included under the one name two other specimens one of which, *Steudner* 1532, is merely a pubescent form of *A. arboreus*, Forsk., while the other is not represented at Kew and has not been seen by the writer.

To *A. pubescens*, Engler, must be referred *A. ugandensis*, C. B. Clarke, published in the Journal of the Linnean Society, vol. xxxvii., p. 527, and including specimens collected by *Dawe* and *Evan James* in Uganda, and by *C. F. Elliott* in British East Africa. These specimens together with the material from Uganda and British and German East Africa placed by Clarke under *A. arboreus*, Forsk., in the Flora of Tropical Africa, and also the

additions received from these countries since the publication of that work compose the Kew material of *A. pubescens*, Engler, as defined in the description below.

Kässner 3185 from German East Africa is a form differing slightly from the typical *A. pubescens* in having shorter, somewhat broader and less acuminate bracts.

The following then is the nomenclature and classification of the specimens of these two species represented in the Kew Herbarium :—

Acanthus arboreus, *Forsk.* (syn. *A. polystachyus*, Delile, probably ; *A. Gaëd*, Lindau).

Abyssinia. *Schimper* 1534, 1535 ; *Plowden* ; *Steudner* 1532, 1533.
Upper Senaar. *Kotschy* 489.

Acanthus pubescens, *Engler* (syn. *A. arboreus*, Forsk., var. *pubescens*, T. Thoms. ; *A. ugandensis*, C. B. Clarke).

Uganda. *Mahon* ; *Dawe* 237 ; *Evan James* ; *Wilson* 94 ; *Mason*.
British East Africa. *C. F. Elliott* 244 ; *Scott Elliott* 7057.
German East Africa. *Speke and Grant* 136 ; *Kässner* 3185.

To sum up, the true *Acanthus arboreus*, Forsk., if identical with *A. polystachyus*, Delile, is a plant of Arabia, Abyssinia, and Somaliland, while *A. pubescens*, Engler, has a more southern range, being common in Uganda and having been several times collected in British and German East Africa.

There is one point which owing to the lack of material has not been completely cleared up. In Trans. Linn. Soc., vol. xxix., p. 129, there is under *Acanthus arboreus*, Forsk., var. *pubescens*, a note by Col. Grant to the effect that the seeds of this plant are "covered with a down which makes the fingers itch." Speke and Grant's specimen at Kew contains no seed. However, in a capsule mounted on the same sheet as the specimen collected by Miss Mason in Uganda is a single seed and this is completely covered with stiff brown hairs which, like the well-known hairs on the fruits of species of *Mucuna*, come off easily on to the hands when rubbed and in any quantity would no doubt cause a noticeable irritation. Hence it seems that there is here another, probably constant, character for distinguishing *A. pubescens* from *A. arboreus* for the seeds of the latter are flat, smooth, and shining.

Acanthus pubescens, *Engler*, Hochgebirgs Fl. Trop. Afr. (1892), p. 390 (Acanthaceae-Acanthoideae) ; descriptionem ampliatam confecit, *W. B. Turrill* ; *A. arboreo*, Forsk., affinis, sed bracteis minoribus, sepalis lateralibus latis saepissime obtusis marginibus molliter ciliatis praecipue differt.

Planta erecta, 1–3 m. alta, caulibus subquadrangularibus glabris vel plus minusve pubescentibus. *Folia* ambitu elliptico-lanceolata, apice acuta spinescentia, basi cordata vel rotundata, usque ad 20 cm. longa, 9 cm. lata, subcoriacea, glabra vel plus minusve pubescentia, irregulariter lobata, lobis spinescentibus, nervis secondariis utrinque usque ad 14 pagina utraque conspicuis, petiolis 1–2 cm. longis. *Spicae* multiflorae ; bracteae ovatae, apice acutae vel acuminatae usque ad 2 mm. longae, 1·5 mm. latae, pagina utraque dense puberulae, marginibus spinescentes ; bracteolae lineari-lanceolatae, apice acuminatae, 1·5 cm. longae, 2–3 mm. latae, pagina utraque puberulae,

marginibus superne spinescentibus. *Sepala* 4, obtusa, dorso plus minusve pubescentia, distincte molliter ciliata ; anticum oblongo-ovatum, apice denticulatum vel integrum, usque ad 1·5 cm. longum, 9 mm. latum ; posticum ovatum, usque ad 1·5 cm. longum, 1·1 cm. latum ; lateralia elliptico-ovata, 1 cm. longa, 7 mm. lata. *Corollae* tubus 7 mm. longus, durus, extra glaber, intus dense pubescens ; limbus 5-lobatus, pubescens, usque ad 3·5 cm. longus, 3·5 cm. latus. *Stamina* 4, filamentis inter se aequalibus 2 cm. longis glabris, antheris 5 mm. longis dense ciliatis ; pollinis granula longe ellipsoidea, 50 μ longa, 30 μ diametro. *Discus* 0·5 mm. altus. *Ovarium* 2 mm. altum, 1 mm. diametro, glabrum ; stylus 2·5 cm. longus, glaber, apice breviter et aequaliter bifidus. *Acanthus arboreus, Forsk., var. pubescens, Thoms, in Speke's Nile Journey, Appendix, p.* 643, and *Oliv. in Trans. Linn. Soc. vol.* xxix., *p.* 129. *A. arboreus, C. B. Clarke in Fl. Trop. Afr. vol.*, v., *p.* 106, pro parte minore, non *Forskal. A. ugandensis, C. B. Clarke, in Journ. Linn. Soc.* xxxvii., *p.* 527.

Tropical Africa. Uganda : Botanic Station, Entebbe, "forms a bush 10 ft. high with handsome, pink, very showy flowers, common," *A. Mahon* ; Buddu, 1170 m. altitude, "a white flowered variety," *M. T. Dawe* 237 ; Elgon District, *Sir Evan James ;* between Entebbe and Kampala, *Miss M. Mason ;* without exact locality, "a stout shrubby plant, branched, 3–7 ft. high, flowers pink. Roadsides and grassland, Uganda, very common. I have also seen a variety with white flowers but have no specimen," *Rev. C. T. Wilson* 94 ; without exact locality, "very handsome pink Acanthacea all over Uganda and Unyoro, 12–15 ft. high," *M. S. Evans* 737 ; British East Africa : Kavirondo, Nandi Range, "a tall shrubby plant, wet ground," *Scott Elliot* 7057 ; Mutagaru, Kakameja Forest, "a very common shrub as undergrowth in forests in Nyanza Province and parts of Uganda," altitude 1350–1500 m., *J. L. Moon* 572 ; without exact locality, *C. F. Elliott* 244 ; German East Africa : Usui (Ussuwi) in Uzinza (Usindja) District, *Speke and Grant*, 136 ; Ruzizi Valley in the open plain, *Kässner* 3185.

LIV.—NEW ORCHIDS ; DECADE 41.

401. **Megaclinium ugandae**, *Rolfe* ; a *M. endotrachyde*, Kränzl., scapo breviore, sepalis lateralibus acuminatis et petalis latioribus differt.

Herba epiphytica. *Pseudobulbi* tetragoni, conico-oblongi, 5 cm. longi, 1·6 cm. lati, diphylli. *Folia* oblonga vel elliptico-oblonga, subobtusa, 7 cm. longa, 2 cm. lata, subcoriacea. *Scapus* circiter 12 cm. longus, basi vaginis tubulosis obtectus ; rachis oblonga, acutangula, 6·7 cm. longa, 8 mm. lata, nervo mediano eccentrico. *Bracteae* triangulares, acuminatae, acutae, reflexae, 3–4 mm. longae. *Pedicelli* 5–6 mm. longi. *Flores* circiter 2 cm. distantes, parvi. *Sepalum* posticum suberectum, subspathulato-oblongum, obtusum, 7 mm. longum ; sepala lateralia late triangularia, reflexa, acuminata, 6–7 mm. longa ; mentum subsaccatum, 2 mm. longum. *Petala*

recurva, oblonga, subacuta, 2 mm. longa. *Labellum* 2·5 mm. longum, carnosum, basi 2 mm. latum, subconcavum, apice recurvum, subobtusum. *Columna* lata, 2 mm. longa ; dentes breves, acuti.

Tropical Africa. Uganda.

Flowered at the Royal Botanic Garden, Glasnevin, in March, 1912, and again a year later. The plant was obtained from Mr. J. O'Brien. The rachis is heavily dotted and marbled with purple brown on a light green ground, and the sepals are of much the same colour outside but more green within. The petals are light green, the lip dull purple and the column whitish-green with numerous minute purple dots.

402. **Eulophia Watkinsonii, Rolfe;** a *E. hiante*, Spreng., colore florum et labelli lobis lateralibus non falcato-divergentibus differt.

Herba terrestris. *Folia* non vidi. *Scapi* 22–40 cm. alti, vaginis spathaceis paucis obtecti ; racemi 6–12 cm. longi, 6–12-flori. *Bracteae* oblongo-lanceolatae vel ovato-oblongae, acutae, 1–1·3 cm. longae. *Pedicelli* 1·5–2 cm. longi. *Sepala* patentia, oblongo-lanceolata, acuta, 1·4–1·6 mm. longa, lateralia carinata. *Petala* subpatentia, ovata vel ovato-oblonga, 1·4–1·5 cm. longa, 6–7 mm. lata. *Labellum* trilobum, 1–1·2 cm. longum ; lobi laterales oblongi, apice late ovati, obtusi, non falcato-divergentes, 3 mm. lati ; lobus intermedius late ellipticus vel ovato-ellipticus, obtusus, 6 mm. latus ; discus basi 2-lamellatus, apice 5-lamellatus, lamellis valde fimbriato-verrucosis ; calcar oblongum vel clavatum, subrectum vel curvatum, 4–5 mm. longum. *Columna* clavato-oblonga, 6 mm. longa. *E. hians*, Rolfe in Dyer Fl. Cap. v. iii. p. 32, ex parte (non Spreng.)

South Africa. Transvaal ; Ermelo, *Watkinson.* Musidora, near Barberton, grassy mountain slopes, 1065 1220 m. *Galpin* 509. Swaziland, *Miss Stewart* 42.

A plant sent from Ermelo (with a corresponding dried specimen) by Mr. H. Watkinson, of the Transvaal Forest Department, flowered at Kew in February, 1913, and proved to have bright yellow flowers with a little brown outside the sepals. It is identical with specimens collected by Galpin and by Miss Stewart, also with a drawing by Mrs. Barber from an unknown locality, which have hitherto been referred to *E. hians*, Spreng., a widely distributed species with purple or lilac and purple flowers. The two closely resemble each other in a dried state. Mrs. Barber's drawing shows the sepals entirely dark brown.

403. **Eulophia ugandae,** *Rolfe ;* affinis *E. latifoliae.* Rolfe, sed pseudobulbis longioribus et labelli calcare clavato differt.

Caules scandentes. *Pseudobulbi* superpositi, subfusiformes, apice attenuati, 2–3-phylli, basi radices crassas emittentes, vaginis tubuloso-spathaceis obtecti. *Folia* petiolata ; limbus ovatus vel elliptico-ovatus, subacutus, subcoriaceus, 8 11 cm. longus, 3·5–4·5 cm. latus ; petioli 2–3 cm. longi. *Scapi* 12–20 cm. longi, vaginis spathaceis obtecti, apice paniculati ; panicula compacta, multiflora. *Bracteae* oblongo-lanceolatae, acutae, 4–5 mm. longae. *Pedicelli* 8 mm. longi. *Flores* parvi. *Sepala* et *petala* subconniventia, oblonga, subobtusa, 8–9 mm. longa. *Labellum* trilobum, 7–8 mm. longum : lobi laterales oblongi, obtusi ; lobus intermedius late obovatus, emarginatus, subundulatus, 3 mm. longus 4 mm. latus ;

discus obscure 2-carinatus, laevis ; calcar clavatum, apice globoso-inflatum, 3 mm. longum. *Columna* clavata, 5·5 mm. longa.

Tropical Africa. Uganda ; Mabira Forest, *E. Brown* 443. " A terrestrial plant. Flowers blue."

Flowered in the collection of Sir Trevor Lawrence, Bart., Burford, Dorking, in March, 1913, the plant having been sent by Mr. E. Brown, who also sent a dried specimen to Kew. How far the flowers vary in colour is uncertain, but those sent by Sir Trevor Lawrence are white, with a few purple radiating nerves on the lip, and a few purple streaks on the face of the column. The climbing habit is remarkable, the new bulbs being regularly produced from above the base of the old one, and sending down a strong root, thus recalling a mangrove in habit.

404. **Lissochilus uliginosus**, *Rolfe* ; affinis *L. purpurato*, Lindl., sed labello latiore et lobo intermedio late ovato differt.

Rhizoma incrassatum. *Folia* non vidi. *Scapi* 1 m. vel ultra longi, erecti, validi, basi vaginis tubulosis obtecti ; racemi circiter 30 cm. longi, laxi, multiflori. *Bracteae* anguste lineares, acuminatae, 1·5–2 cm. longae. *Pedicelli* subgraciles, 2·5 cm. longi. *Sepala* patentia, undulata ; posticum ovato-oblongum, subobtusum, 1·5 cm. longum ; lateralia oblonga, obtusa, 2 cm. longa. *Petala* oblonga, obtusa, undulata, circiter 2 cm. longa, sepalis lateralibus paullo angustiora. *Labellum* trilobum, fere 2 cm. longum ; lobi laterales erecti, semiovato-oblongi, obtusi, 8 mm. longi ; lobus intermedius ovatus, obtusus, crenulato-undulatus, 1·2 cm. longus, 1 cm. latus, incurvus ; discus carinis 5 crassiusculis et obtuse verrucosis instructus ; calcar conicum, subacutum, circiter 7 mm. longum. *Columna* clavata, apiculata, 7 mm. longa.

Tropical Africa. Gold Coast Colony : Western Province ; Chama, in grassy fresh water swamps in savannah forest, *Chipp* 192.

405. **Polystachya coriacea**, *Rolfe* ; a *P. golungensi*, Reichb. f., foliis latioribus, scapo brevioribus et floribus minoribus differt.

Herba epiphytica, 15–18 cm. alta. *Pseudobulbi* oblongi, 2·5–3 cm. longi, diphylli. *Folia* lineari-oblonga, bidentata, subconniventia, crasso-coriacea, 10–14 cm. longa, 1·3–1·5 cm. lata. *Scapi* 7–9 cm. longi, basi vaginis spathaceis angustis imbricatis obtecti ; racemi basi interdum sparse ramosi, 3–4 cm. longi, densiflori, rachi pubescente. *Bracteae* triangulari-oblongae, subacutae, 1 mm. longae. *Pedicelli* 2 mm. longi. *Flores* minuti. *Sepalum* posticum ovato-oblongum, subobtusum, concavum, 1·5 mm. longum ; sepala lateralia triangularia, acuta, 2 mm. longa ; mentum obtusum, 1·5 mm. longum. *Petala* lineari-oblonga, obtusa, 1·5 mm. longa. *Labellum* obovato-oblongum, trilobum, 2 mm. longum ; lobi laterales rotundato-oblongi, 0·5 mm. longi ; lobus intermedius suborbicularis, emarginatus, 1 mm. latus ; discus pulverulento-pubescens. *Columna* lata, 0·5 mm. longa.

British Central Africa.

Flowered in the collection of Mr. James Bush, Bryn Asaph, Romilly Road, Cardiff, in March, 1913. The flowers are deep yellow in colour.

406. **Xylobium elatum**, *Rolfe* ; a *X. scabrilingui*, Rolfe ; sed foliis et scapis multo longioribus et floribus numerosissimis differt.

Pseudobulbi ovoideo-oblongi, 5–7·5 cm. longi, diphylli. *Folia* longe petiolata ; limbus lanceolatus vel elliptico-lanceolatus, acutus, plicatus, 40–50 cm. longus, 8–10 cm. latus ; petiolus 20 cm. longus. *Scapus* 90 cm. altus, vaginis spathaceis paucis obtectus ; racemus circiter 18 cm. longus, multiflorus. *Bracteae* lineari-lanceolatae, acuminatae, 1·5–2 cm. longae. *Pedicelli* 2–2·3 cm. longi. *Sepala* oblonga, subobtusa vel apiculata, 1·6–1·8 cm. longa ; lateralia subfalcata ; mentum obtusum, 3–4 mm. longum. *Petala* oblonga, subobtusa, 1·4–1·5 cm. longa. *Labellum* 3-lobum, 1·2 cm. latum, fere omnino prominenter tuberculato-papillosum ; lobi laterales obtusi vel truncati, erecti ; lobus intermedius elliptico-oblongus, obtusus, carnosissimus ; discus callo oblongo laevi instructus. *Columna* lata, 6–7 mm. longa, marginibus angulatis.

Peru. *L. Forget.*

Introduced by Messrs. Sander & Sons, and flowered in their Establishment at Bruges, Belgium, in May, 1913. It is characterised by its tall habit, the scape being as much as three feet high and the leaves correspondingly large. The flowers are dull pale green, heavily marbled with brown on the back of the segments ; the very prominent tubercles on the lip are dark brown.

407. **Xylobium ecuadorense**, *Rolfe* ; a *X. foveato*, Nichols., floribus minoribus, labello latiore et carinis ternis differt.

Pseudobulbi ovoideo-oblongi, 5–6 cm. longi, apice diphylli. *Folia* petiolata, arcuata, elliptico-lanceolata, acuminata, 13–20 cm. longa. *Scapi* suberecti, subgraciles, 12–15 cm. longi, squamis paucis lanceolatis obtecti. *Bracteae* angustissime lineares, acuminatae, 1·5–2·5 cm. longae. *Pedicelli* graciles, 1·5 cm. longi. *Sepalum* posticum lanceolatum, subacutum, 1·5 cm. longum ; lateralia falcato-lanceolata, subacuta, dorso carinata, 1·5 cm. lata, basi cum columnae pede in mentum conicum 5 mm. longum extensa. *Petala* falcato-lanceolata, subacuta, 1·2 cm. longa. *Labellum* obovato-oblongum, prope apicem trilobum, 1·2 cm. longum ; lobi laterales anguste oblongi, apice obtusi ; lobus intermedius obovato-quadratus, emarginatus, 4 mm. latus. *Columna* clavata, 8 mm. longa.

Ecuador. Naranajapata, about 75 miles from the coast, 300 m., *L. J. Lipscomb.*

Sent for determination by Mrs. Lipscomb, Wilton Grove, Wimbledon, who informs us that it was sent from Ecuador by her son, Mr. Lancelot J. Lipscomb, in 1911. The flowers are uniformly light yellow in colour.

408. **Trichocentrum panamense**, *Rolfe* ; a *T. capsicastro*, Linden et Reichb. f., scapis paucifloris et labelli calcare breviter quadrilobo differt.

Herba epiphytica, parva, epseudobulbosa. *Folia* lineari-oblonga, obtusa, carnosa, 4–7·5 cm. longa, 1–1·8 cm. lata. *Scapi* horizontales, flexuosi, 4–6 cm. longi, pauciflori. *Bracteae* conduplicatae, ovatae, acutae, 6–8 mm. longae. *Pedicelli* circiter 1 cm. longi. *Flores* parvi. *Sepala* et *petala* subconniventia, oblongo-lanceolata, subacuta, subconcava, circiter 2·3 cm. longa. *Labellum* elliptico-oblongum, obtusum, conduplicato-concavum, 1·2 cm. longum, basi margini columnae adnatum ; calcar breve, dilatatum, 2 mm. longum, apice

breviter quadrilobum. *Columna* crassa, 5 mm. longa ; alae falcato-oblongae, obtusae, integrae, 4 mm. longae, 3 mm. latae ; anthera insigniter papilloso-cristata.

Panama. On bush-covered hills east of the Panama Canal, 255 m., *L. J. Lipscomb.*

Flowered in the collection of Mrs. Lipscomb, Wilton Grove, Wimbledon, in November, 1911, the plant having been received some two years previously from Mr. Lancelot J. Lipscomb. The species is anomalous in the shape of the spur, which is very short, dilated, and divided at the apex into four short lobes. The flowers are light green, with a white lip, at the base of which is situated a red-purple blotch. The spur is yellowish and there are a few minute purple dots on the column-wings.

409. **Sigmatostalix bicornuta**, *Rolfe* ; habitu *S. gramineae*, Reichb. f., sed labello multo latiore, et petalis basi dente conico brevi instructis differt.

Planta caespitosa, circiter 6 cm. alta. *Pseudobulbi* elliptico-oblongi, subcompressi, circiter 1 cm. longi, apice monophylli, basi tetraphylli. *Folia* linearia, subobtusa vel minutissime denticulata, basi conduplicata, 3–5 cm. longa, 1·5–2 cm. lata. *Scapi* laterales, graciles, 4–5 cm. longi, pauciflori. *Bracteae* fasciculatae, 3–4, elliptico-lanceolatae, acutae, 2–3 mm. longae, pedicellos involventes. *Pedicelli* 2–3 mm. longi. *Flores* parvi. *Sepala* lineari-lanceolata, subacuta, reflexa, 3–3·5 mm. longa ; lateralia sublibera. *Petala* lineari-lanceolata, subacuta, apice subrecurva, 3–3·5 cm. longa, facie prope basin dente conico brevi instructa. *Labellum* sessile, subpatens, reniformi-orbiculare, minute apiculatum, 4 mm. latum, margine recurvo et crenulato, basi et medio callo carnoso transverso nitido instructum. *Columna* clavata, 2·5 mm. longa, basi gracilis.

Peru. *L. Forget.*

Imported by Messrs. Sander & Sons, and flowered in the Royal Botanic Garden, Glasnevin, in January, 1912, whence it was sent by Sir F. W. Moore for determination. The flowers are yellow, with a deep purple-red stripe on the dorsal sepal and petals. The specific name refers to the two fleshy conical horns on the petals, a quite unusual character.

410. **Saccolabium glomeratum**, *Rolfe* ; a *S. penangiano*, Hook. f., racemis brevioribus et congestis, floribus fere duplo majoribus et labelli calcare oblique clavato differt.

Herba epiphytica. *Caulis* circiter 20 cm. altus. *Folia* disticha, patentia vel subrecurva, lanceolata, acuminata, valde coriacea, circiter 9 cm. longa, prope basin 1 cm. lata. *Racemi* axillares, brevissimi, subglomerulati, 2–2·5 cm. longi, congesti, multiflori, rachi pubescente. *Bracteae* lineares, subacutae, incurvae, valde concavae, 4 mm. longae. *Pedicelli* pubescentes, 6 mm. longi. *Flores* parvi. *Sepalum* posticum cuneato-oblongum, acutum, incurvum, valde concavum, 4 mm. longum ; sepala lateralia subconniventia, ovata, subobtusa, 3·5 mm. longa. *Petala* subpatentia, lanceolato-oblonga, subobtusa, 3·5 mm. longa. *Labellum* valde carnosum, trilobum ; lobus intermedius linearis vel subfiliformis, acutus, recurvus, 2–2·5 mm. longus ; lobi laterales lati, 1·5 mm. longi, columnae adnati, apice profunde bidentati, dentibus acutis ; calcar valde carnosum,

late oblongum, apice oblique clavatum, 5–6 mm. longum, intus nudus. *Columna* latissima, 2·5 mm. longa; antherae stipes superne late triangulari-dilatatus.

Borneo.

Flowered in the collection of the Hon. N. C. Rothschild, Ashton Wold, Oundle, in October, 1913. The flowers are yellow, spotted with brownish red on the sepals and petals, and striped with similar colour on the side lobes of the lip.

LV.—NEMATODES OR EELWORMS.

G. Massee.

(With plate.)

Nematodes or Eelworms belong to the class Vermes, which includes earthworms; the latter, however, are much more highly organised than eelworms. Tape worms and liver flukes are also closely related. Nematodes are very numerous and widely distributed in nature. The majority of species are saprophytes, and abound in stagnant water, decaying vegetable matter, manure, soil in damp places, &c. The vinegar eelworm, *Anguillula aceti*, is a well-known example of this group. The saprophytic species are not at all injurious to living animals or plants, and may be looked upon as scavengers in a small way, causing the disintegration of organic matter, and rendering it once more available for plant life. On the other hand, certain nematodes are parasitic on animals or plants. *Trichina spiralis* forms very minute, white, chalky looking lumps in the flesh of pigs, and was the cause of a scare some years ago, when it was reported that the parasite might prove a source of danger to human beings; many kinds of worms infesting human beings are also nematodes. The majority of nematodes are long and slender or eel-like in shape during some stage of their development, hence the popular name, eelworm, this, however, is merely a book-name, as with few exceptions they are so very minute that they cannot be seen with the naked eye. Not more than half-a-dozen kinds of eelworms are destructive to plants in this country, but the amount of acknowledged injury caused by their presence is enormous, and it is practically certain that many diseases usually attributed to other causes are primarily due to eelworms. As an example, several diseases of violets, especially when grown in frames, and usually attributed to fungi, are in reality due to the presence of eelworms in the root, where they form minute galls, which contort and destroy the continuity of the water-conducting cells. The plant is as a consequence deprived of the necessary amount of water and food, and the foliage is inclined to wilt, when it is readily attacked by various kinds of fungi, which have been proved by experiments to be unable to infect normal and healthy violet plants.

A quarter of a century ago, with a few notable exceptions such as rust of wheat, &c., fungi were not credited with being active agents in causing injury to plants; at the present day the pendulum has

swung to the opposite extreme, and fungi are gravely suspected as being the cause of almost every important disease attacking plants of economic value. Epidemics caused by fungi among wild plants in a state of nature are practically unknown. It will, I believe, be generally admitted that plants cultivated under glass are much more susceptible to attacks from fungi than when the same kinds of plants are grown out of doors, in fact I usually fail to infect plants growing in the open with spores obtained from the same kinds suffering from an epidemic when grown under glass. A good deal of evidence could be given on the same lines, to show that fungi are not so much to blame as is usually supposed for being the primary cause of plant diseases. Experience has proved that fungi undoubtedly are the cause of an enormous loss to cultivators of plants, either as primary or secondary agents, and as the injury caused by the fungus is much more obvious than that produced by the primary cause, it is usually concluded that the injury is entirely due to the fungus, whereas in reality, but for the road being made clear by the primary agent, the fungus, which completes the work of destruction, could not have gained a foothold. For the above reasons I am led to consider that attention to fungi alone is but a poor equipment for a post as plant pathologist, and will not lead to a reduction of the losses caused indirectly by fungi, which can never be exterminated.

Among the known primary agents which enable the large class of fungi known as wound-parasites or facultative parasites to gain an entrance into plant tissues may be enumerated insects of various kinds, which by eating, and more especially by simply puncturing the tissues, enable the germ-tubes of spores to gain a foothold, at first by obtaining food from the injured cells and living as saprophytes, then gradually assuming a parasitic habit and invading the living tissues of the host-plant. In many instances not only do insects—aphides, mites, scale-insects, &c., enable the fungus to gain an entrance into a plant, but they also unconsciously carry and deposit the spores of the fungus in the punctures made. Injury caused to young leaves and tender shoots by hail is frequently followed by an epidemic, fungus spores germinating readily on the bruised tissues. Climatic conditions are a most important factor in determining the presence or absence of epidemics due to fungi; marked contrasts in temperature during the spring months invariably mean an excess of injury caused by fungi, whereas an equable temperature during the same period is marked by a comparative absence of disease. The same applies if extremes of temperature occur between day and night in conservatories, &c. I have frequently cultivated fungi, *Botrytis*, *Fusarium*, *Trichothecium*, that have commenced their parasitic career in old, partly decomposed nodules on the roots of leguminous plants.

The above remarks, of course, apply to the great number of fungi oscillating between parasites and saprophytes, and which only become true parasites under special circumstances. The extension of disease due to fungi is favoured in many ways by modern methods of cultivation as the marked extension of fungi in space is facilitated by rapid transit. In this respect opportunity is a factor of primary importance. I think it may be stated, without fear of contradiction, that no living

organism, in a state of nature, enjoys the opportunity of performing all that it is capable of doing. The constant struggle for existence, or whatever phrase be preferred, that compels every animal and plant to be content with the mean, or give and take policy, prevents the accomplishment of such an ideal. Even the fittest, judged from the standpoint of number of individuals and distribution in space, are amendable to opportunity. If this argument be sound, it follows that the extension of disease amongst cultivated plants, nay even the creation of new diseases, due to fungi, should be great, as the opportunities indirectly and unknowingly, to most people, are many and far reaching. As it has been abundantly demonstrated, that the education of a saprophytic fungus to change its nature, and become a rampant parasite, is a simple matter in the laboratory, it may be assumed that when facilities are offered outside the laboratory the same change would be effected. Among such opportunities for ordinarily saprophytic fungi to change their mode of life may be mentioned the constant wounding of plants, due to careless planting, "heeling in," grass-cutting machines injuring roots, pruning, &c. The principal reason why there are no epidemics due to fungi in virgin forests and uncultivated places is because host and parasite have lived together for an indefinite period of time, and by a process of elimination the survivors are able to live side by side without either being capable of exercising any very marked superiority. On the other hand, when a new and strange plant is introduced into a virgin forest or to a new country the inevitable epidemic caused by fungi follows. The new importation being altogether unprepared to combat an enemy of which it has had no previous experience at first falls a victim, but as the process of elimination of the least resistent goes on, the epidemic subsides. It is a well-known fact that in the majority of instances the initial period of an epidemic attacking a plant for the first time is most severe after which it gradually subsides. Why? When the hollyhock disease first appeared in Europe it rendered the cultivation of that plant well-nigh impossible. To-day hollyhocks are again in cultivation, and although the rust is present it does no material harm, although the opportunities for infection are ample, in fact much more so than when the epidemic first appeared, as the disease is now met with on malvaceous plants throughout Europe. Again, why? Those elusive conditions of the host-plant appear to offer the most promising field for research, where the primary object is that of reducing the loss directly or indirectly due to fungi. Judging from results, the so-called life histories of fungi, apart from the host, are not likely to lead to the desired result.

To return to eelworms.

Heterodera radicicola, *Mull.*, the gall-forming eelworm, is best known, and does the greatest amount of damage in this country. The egg is large in size, compared with the worm, colourless, elliptic-oblong, about $\frac{1}{250}$ of an inch in length. The covering is very thin and translucent, so that at a certain stage the minute worm can be distinctly seen in its interior. Although so thin the wall is very tough and resistant to extremes of heat and cold, chemical substances, &c., and the germ is with difficulty killed. The worm usually escapes from the egg in the gall, and is a tiny

eel-like body quite invisible to the naked eye. The young worms soon find their way into the soil, when they at once proceed to attack any other rootlets that may be present. Should the rootlets not be forthcoming, according to Stone and Smith, they are capable of existing for a considerable time without change, awaiting an opportunity for further development. Having effected an entrance into a young root, aided by means of a moveable spear-like body situated within the mouth-opening, and the whole body becoming immersed in the tissues, the worm comes to rest, and undergoes some remarkable changes. Briefly, in both males and females the body becomes swollen at the centre until it is spindle-shaped. Afterwards the male again assumes an eel-like form, whereas the female continues to enlarge and becomes more or less lemon-shaped. At this stage fertilisation is supposed to take place, after which the males perish, and the stationary females produce numerous eggs in their interior. When the eggs are mature the female dies. Sections of a gall at this stage shows the more or less spherical bodies of the females crowded with eggs, the body showing as a whitish speck to the naked eye. Usually several bodies of distended females may be seen in one section, as they are more or less gregarious in habit. The swollen portions or galls vary much in size on different plants. On vine roots they are usually small, rarely exceeding the size of a pea; on the tomato they are frequently the size of a marble, whereas on some plants the galls are as large as a walnut or even larger. The galls are always formed on the root or on some underground part of the plant. In a section through a gall the vascular bundles and water-conducting vessels will be seen to present a contorted and dislocated appearance. When galls are numerous on the root, as is usually the case, the root is prevented from performing its function of supplying the above-ground portion with water containing food substances in solution, consequently the plant literally dies of hunger and thirst, as is also the case when the passage of water is interrupted by the presence of fungus mycelium in the tissues of the root and collar.

There appears to be little or no discrimination in the choice of a food-plant by nematodes; Kühn, a German observer, enumerates a list of 180 plants, belonging to 39 orders; amongst these grasses are most favoured, 46 species being attacked by eelworms; Leguminosae 33 kinds, &c. Eelworms may be commonly found infesting wild grasses in this country, hence the popular idea that turf from an old pasture is perfectly free from eelworms and other pests, is not necessarily correct.

In this country cucumbers and tomatoes suffer most severely from the ravages of eelworms; this, however, is not due to any special preference on the part of eelworms for these plants, but is simply due to the method of cultivation under glass, where the soil becomes infected, and only half-hearted measures are adopted for the purpose of securing immunity from a pest admittedly difficult to exterminate. Among other plants of economic importance attacked by *H. radicicola* are vines, potatoes (tubers), roses, Phloxes and Balsams; less frequently fruit trees are attacked; but, as already stated, in the case of stunting of the foliage, the absence of thriftiness,

or wilting, the presence of eelworms in the root may be suspected, whatever kind of plant may be concerned. The most obvious indication of the presence of eelworms is the galled or knotted appearance of the root. This, however, is but a suggestion, and should be corroborated by microscopic examination, as galls on the root may be due to other causes. For example, the swellings on the roots of cabbages, caused by the cabbage root fly, *Phorbia brassicae*; finger-and-toe, on the roots of various cruciferous plants, due to the presence of *Plasmodiophora brassicae*, &c. Tubercles are normally present on the roots of leguminous plants, but galls formed by nematodes may often be found intermixed on the same root.

So far as preventive or curative methods are concerned, there is no known method by which the eggs of eelworms can be killed in open ground, and even when treating a limited amount of soil in houses, the most drastic measures, accurately applied, can alone command success. The reason why eelworms are so difficult to exterminate arises from the fact that eggs are produced in immense numbers throughout the year, or at all events so long as living roots are available, and young eelworms are constantly being liberated into the soil, consequently the dressing capable of killing eelworms should be repeated for a considerable number of times, extending over a long period of time, which becomes almost impracticable. A dressing of sulphate of potash, 3 cwt. per acre, will kill all active eelworms with which it comes in contact, and however well it may be worked into the soil many will escape, and its efficacy soon passes away. When, however, a growing crop is suffering from eelworm, the application of sulphate of potash, if at a sufficiently early date, will check the progress of the disease to some extent, but it will not prove a permanent cure, since the eggs are not destroyed. The application of lime is practically useless against eelworm. Gaslime, now hardly procurable, is a more satisfactory remedy, as its lasting power in the land means the death of successive generations, but to obtain this end the land must lie fallow for some time. The use of a " trap crop " is advocated by German experts, where the injury to sugar-beet by eelworm is often considerable. The idea of a trap crop is to grow on infected land some plant readily attacked by eelworms, the crops should be pulled up and sun-dried, if practicable, when a considerable number of larval nematodes have entered the roots, and before a new brood is produced; summer rape is recommended for this purpose, on account of its quick growth and great spread of root. Success of course entirely depends on the removal of the crop at the proper time. This method so far reduces the number of eelworms present in the land that a fairly good crop may be secured, but its effect is not lasting.

For the complete destruction of eelworms in soil in tomato and cucumber houses, &c., the method recommended by Stone and Smith is as follows :—

" The most effectual, complete, and practical method at the present time of exterminating nematodes in greenhouses is by heating the soil by means of steam. This can be accomplished without much expense providing proper attention is paid to the method of applying the steam. A pressure of steam exceeding 50 lbs. is not only

cheaper but more effective than a pressure which falls below this, and the amount and cross section area of the tile [pipe] is important. The cost of heating soil depends upon the equipment employed and cost of labour, &c. Probably not far from 100 cubic feet of soil under the most favourable conditions can be heated in one hour's time to a temperature of over 200° F. The minimum amount of heat necessary to kill nematodes and their eggs while confined to the soil is about 140° F., but for all practical purposes it is desirable to make use of a higher temperature, at least from 180°–212° F. The benefit of steaming or sterilising soil is not alone confined to nematodes. Many other greenhouse pests are killed. The mechanical conditions of the soil are moreover greatly improved, the numerous compounds are rendered more available for plant food, which results in giving plants grown in a sterilised soil a considerable acceleration in their rate of growth." Full details and plans relating to the sterilisation of soil by steam, are given in Bull. No. 55, Hatch Experiment Station, Mass., U.S.A.

It has been suggested that dressing the soil with rape meal destroys eelworms. This may possibly hold in check or kill active eelworms, but it will not kill the eggs.

It is well known that a poor physical condition of the soil not only favours the spread of eelworms, but also prevents their destruction, owing to the difficulty of diffusion and permeation of the remedial agent applied.

Potassium permanganate, 1 part in 200 parts, kills eelworms, if the soil is saturated at intervals of ten days, and does not injure growing plants. This again may be used to save a growing crop, but as it has no effect on the eggs, it must not be depended upon for exterminating the pests. Finally, carbon bisulphide injected into the soil will kill any active eelworms present.

Heterodera schachtii, *Schm.*—The sugar beet eelworm differs from *H. radicicola* in not forming galls or knots on the roots of the host-plant. The young females only penetrate the peripheral layer of the rootlet, and on increasing in size burst through to the surface, remaining attached by a narrowed portion only, hence an attacked rootlet presents a knotted appearance, figs. 1 and 8, the knots being the external distended females and not galls of plant tissue. *H. schachtii* is a serious pest in the sugar beet fields in Germany, but up to the present, so far as I am aware, has not been recorded on sugar beet in this country. Quite recently, however, *H. schachtii* has proved destructive to potatoes in Scotland, where the rootlets are attacked in a similar manner to the rootlets of sugar beet, fig. 8. This discovery is of some importance, as plants belonging to *Solanaceae*, *Papaveraceae*, *Compositae* and *Umbelliferae* respectively are stated by Voigt to be free from the attacks of this pest. Potatoes have been recommended for growing on infested beet-growing land, along with a trap crop of rape, for the double purpose of obtaining a crop and reducing the number of eelworms at the same time. It certainly would not be wise to follow this course in Great Britain. It may be stated that *Oospora scabies*, a fungus causing a scab on potato tubers, also attacks sugar beet, which is an additional reason why these two crops should not alternate, as *O. scabies*

when once introduced into the land is somewhat difficult to eradicate. When sugar beet is attacked in the seedling or young stage, the formation of a tap-root is arrested, and several long, slender rootlets take its place, to which numerous distended female eelworms are attached, fig. 1. This eelworm has been observed on about 50 different kinds of plants, among which may be mentioned, mangolds, cabbages, radish, spinach, *Agrostemma githago*, &c. The treatment for the destruction of this eelworm is the same as for *H. radicicola*.

Tylenchus devastatrix, *Ritzema Bos*, is a third eelworm which often proves very injurious to several outdoor crops. Clover sickness, which is frequently attributed to the exhaustion of some ingredient of the soil necessary for the growth of clover, is in reality caused by this eelworm. The symptoms are a yellowing of small, usually scattered patches; these patches gradually increase in size, and according to the severity of the attack, and the rate of spread of the eelworms through the soil, the crop becomes more or less involved. In the end the attacked plants become brown and dead, leaving bare patches in the field. A clover plant infested with eelworms presents a very characteristic appearance. The branches, where they spring from the root, are very much swollen and often distorted, whereas in the normal plant the branches are thin and wiry. A section through the swollen part reveals the presence of female eelworms or their eggs. If the diseased patches are observed when quite small, dig up the plants and burn them on the spot when dry, taking care to remove the plants well beyond the zone of apparent injury. Then dress with sulphate of potash as previously advised.

"Segging" of oats, or "Tulip root," is also caused by *Tylenchus devastatrix*. The symptoms are the swollen appearance at the base of the culm, which bears a number of swollen distorted shoots. Diseased plants remain stunted and eelworms or their eggs will be found in the swollen parts. Deep ploughing, where allowable from other standpoints, and treatment by sulphate of potash are recommended for infected land, which should not be sown with a crop susceptible to the disease such as clover. Barley or root crops are safe.

Microscopic examination is necessary for the certain determination of the presence of eelworm, as the base of the culm in oats is also swollen in a similar manner when attacked by the frit fly (*Oscinis frit*).

The same eelworm is the cause of a disease of the strawberry plant. The plants rot and decay at the ground level and the leaves are often crinkled and deformed at an early stage. Diseased plants should be removed and burned, and the land treated with sulphate of potash.

Aphelenchus fragariae, *Ritzema Bos.* is the cause of a second disease of strawberry plants, known as the "cauliflower" disease, Diseased plants present a fasciated appearance, the stems and leaves being consolidated into an irregular fleshy mass, suggesting

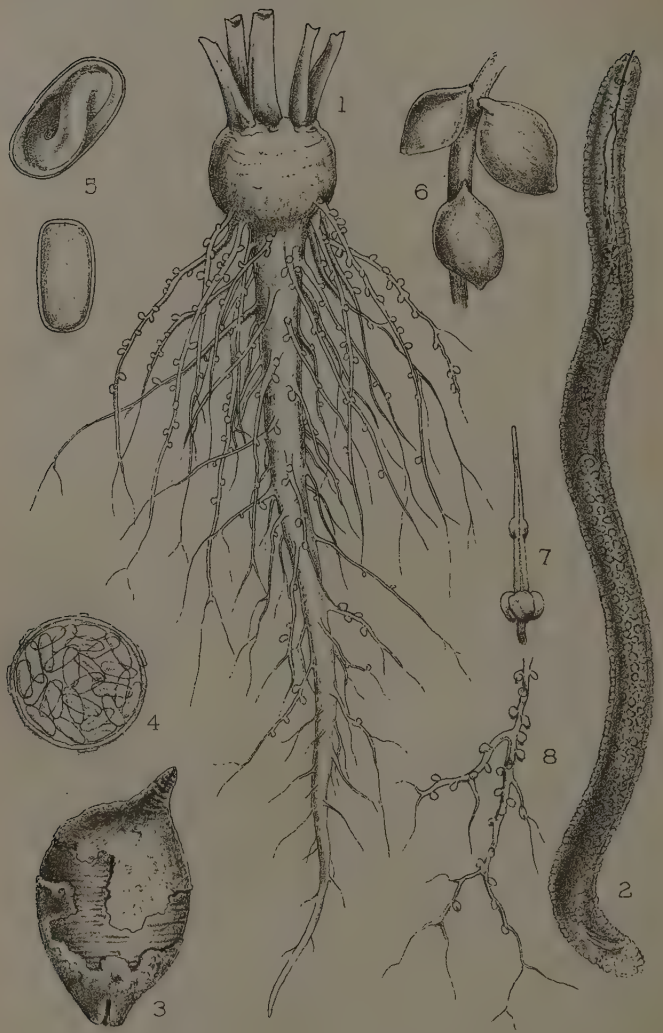
a cauliflower. The flowers also assume monstrous forms. Diseased plants should be removed and sulphate of potash applied.

Tylenchus tritici, *Bastian*, the cause of "Ear-cockles" of wheat, is sometimes responsible for a considerable shortage of the wheat crop. The grain, which is the part attacked, becomes changed into a roundish, blackish-purple mass, somewhat smaller in size than a normal grain. As a rule almost every grain in the ear is attacked. When a diseased grain is crushed and examined under the microscope numerous eelworms will be seen wriggling about in a characteristic manner. A similar temporary wriggling occurs when infected grains, that are over fifty years old and have been kept perfectly dry all the time, are crushed and placed in water. This was at one time supposed to demonstrate the extreme vitality of life under desiccation. Such eelworms, however, are dead, and the wriggling is simply due to the absorption of water by their desiccated bodies, which causes them to expand. When the body of an eelworm is once saturated with water and properly expanded all movement ceases. This phenomenon is clearly shown in specimens of "earcockle" grains included in a pioneer work on plant diseases, by Edwin Sidney, entitled "Blights of the Wheat, and their remedies," 1846.

When infected grains are sown together with healthy ones, they become soft, and the eelworms escaping into the ground make their way to the sprouting wheat, and insert themselves under the leaf-sheaths, where they remain until the ear begins to develop; when they enter the soft, young grain, and a gall or ear-cockle results.

If seed grain containing ear-cockles is placed in water, and well stirred up, the lighter, diseased grains float, and can be skimmed off.

Aphelenchus olesistus, *Ritzema Bos*, the Fern eelworm, forms brown streaks or patches on the living fronds of various kinds of ferns. The shape of the brown patches is determined by the venation of the particular fern attacked. Where the veins are more or less parallel, as in *Lygodium*, *Pteris*, &c, the blotches are long and narrow, extending from the mid-rib to the margin of the pinnule; where the veins anastomose irregularly the blotches are more or less angular. This is due to the fact that the eelworms in the tissues of a fern frond cannot penetrate beyond the portion circumscribed by a vein. When the air is moist the eelworms leave old patches and enter adjoining healthy parts through the stomata. When the air is fairly dry, this migration is checked. In addition to ferns, this eelworm attacks the leaves of many kinds of flowering plants, *Chrysanthemum*, *Begonia*, *Calceolaria*, *Gloxinia*, *Coleus*, &c, forming more or less extended brown patches, frequently mistaken for the injury done by *Thrips*. This eelworm breeds in the soil, and enters the leaves of the plants for food only. Treating the soil with carbon bisulphide kills the eelworms, but not their eggs, hence the treatment must be constantly repeated until the pest is exterminated. Dusting the under surface of the leaves, and more especially the stems near the ground, with a mixture of tobacco powder and flowers of sulphur, when moist, will prevent the eelworms from ascending and entering the tissues.



Sugar beet Eelworm.

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Aphelenchus olesistus has caused considerable trouble in the fern houses at Kew. A short account of this eelworm was given in *K.B.*, 1909, pp. 243, 244, and the accompanying text figure is reproduced from that volume. *Aneimia collina*, *Pteris Droogmantiana*, *Adiantum Capillus-veneris*, and *Lygodium volubile* have been among the ferns more particularly attacked.

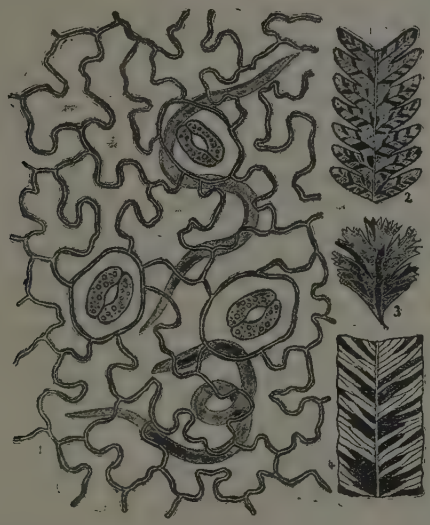

Fig. 1. *Aneimia collina*, Raddi, showing the eelworms in the tissue of the frond under the epidermis × 300.

Fig. 2. *Pteris Droogmantiana*, L. Linden. The dark streaks are caused by the eelworm.

Fig. 3. *Adiantum Capillus-veneris*, f. *fissa*, showing dark patches due to eelworm.

Fig. 4. *Lygodium volubile*, Sw., with dark streaks caused by eelworm.

Explanation of Figures in Plate.

Heterodera schachtii, Schm.

1. Young sugar beet attacked by eelworm. Nat. size.
2. Male of sugar beet eelworm. × 500.
3. Female of sugar beet eelworm. × 500.
4. Section of female of same filled with eggs. × 500.
5. Eggs of same in different stages of development. × 1200.
6. Female eelworms of sugar beet attached to rootlet of sugar beet. × 250.
7. Spear, or piercing apparatus of eelworm. × 1200,
8. Sugar beet eelworm on rootlets of potato. Nat. size.

LVI.—DECADES KEWENSES

Plantarum Novarum in Herbario Horti Regii Conservatarum.

DECAS LXXXV.

731. **Bauhinia comosa**, *Craib* [Leguminosae-Caesalpineae]; ab affini *B. saxatili*, Craib, racemis densioribus, rhachi pedicellisque crassioribus, legumine latiore recedit.

Ramuli breviter tomentelli, brunneo-corticati. *Folia* ambitu late ovata vel suboblonga, basi late cordata, ad 7·5 cm. longa et 6·4 cm. lata, circiter ad medium biloba, lobis obtusis ad 3·5 cm. longis et latis, rigide chartacea, supra ima basi excepta glabra, subtus primo tenuiter adpresse pubescentia, mox plus minusve glabrescentia, 9-nervia, nervo mediano in apiculum tenuem ad 5 mm. longum excurrente, nervulis uti reticulatione supra conspicuis vel subprominulis subtus prominulis, petiolo ad 1·7 cm. longo suffulta. *Racemi* densiusculi, ad 28 cm. longi, pedunculo communi 1·7–2·3 cm. longo indumento ut rhachi ramulisque suffulti; pedicelli sub anthesin 6 mm., infructescentes 1 cm. longi, breviter densius pubescentes; bracteae deciduae, 6 mm. longae, bracteolis geminis 4 mm. longis. *Calycis* tubus vix 2 mm. longus; segmenta 5 mm. longa, 2 mm. lata, dorso adpresse pubescentia. *Petala* lutea (ex *Henry*), anguste oblonga, acuminata, vix 6 mm. longa, 1·5 mm. lata, inferne in unguem brevem contracta. *Stamina* 3, filamentis 6 mm. longis glabris, antheris in alabastro 2 mm. longis, staminodiis minutis. *Pistillum* glabrum; ovarium 3 mm. altum, 6–8-ovulatum, stipite 1·25 mm. longo suffultum, stylo circiter 2 mm. longo. *Legumen* compressum, 7·3 cm. longum, 2·1 cm. latum, stipite 2·5 mm. longo suffultum.

China. Yunnan: Linan, 1350 m., *Henry* 13,358.

732. **Bauhinia genuflexa**, *Craib* [Leguminosae-Caesalpineae]; *B. Henryi*, Craib, facie similis sed ramulis fusco-corticatis, alabastris angulum circiter 90° cum pedicellis efficientibus distinguenda.

Ramuli primo sparse adpresse pubescentes, mox glabri, fusco-corticati. *Folia* ambitu subrotundata, basi cordata, ad 5 cm. longa et 5·3 cm. lata, apice biloba, lobis rotundatis ad 1 cm. longis et 2·4 cm. latis, rigide chartacea, 7-nervia, nervis subtus prominentibus, nervulis uti reticulatione gracili pagina utraque conspicuis, supra glabra, subtus nervis parcissime adpresse pubescentia et ima basi in nervorum axillis ferrugineo-pubescentia; petioli 1–2·3 cm. longi, supra canaliculati, fere omnino glabri; stipulae 2·5 mm. longae, 0·75 mm. latae, superne falcatae, glabrae. *Corymbi* ad 4 cm. longi et 6·5 cm. diametro, rhachi, pedicellis alabastrisque plus minusve adpresse ferrugineo-pubescentibus; pedicelli ad 2·7 cm. longi; bracteae 6·5 mm. longae, bracteolis geminis alternis 4–5 mm. longis; alabastra ellipsoidea, angulum circiter 90° cum pedicellis efficientia. *Calycis* tubus basi gibbosus, 5 mm. longus; segmenta 5 mm. longa, 2 mm. lata. *Petala* albo-viridia (ex *Morse*), inter se inaequalia, ad 6 mm. longa et 5·5 mm. lata, ungui ad 2 mm. longo suffulta, dorso pilosa. *Stamina* 3, filamentis 6·5 mm. longis glabris,

antheris rubris (ex *Morse*) in alabastro 2·5 mm. longis. *Ovarium* 3 mm. altum, inferne suturis ferrugineo-pubescens, stipite 2 mm. longo ferrugineo-pubescente suffultum; stylus 3 mm. longus, glaber.

China. Kwangsi: Lungchow; Sim Kee gorge, *Morse* 408.

733. **Bauhinia Henryi**, *Craib* [Leguminosae-Caesalpineae]; a *B. touranensi*, Gagnep., ovario distincte stipitato recedit.

Ramuli juventute fere glabri, mox omnino glabri, cortice pallide brunneo nitido vel subnitido obtecti. *Folia* ambitu subrotundata, basi cordata, ad 6·2 cm. longa et 6·8 cm. lata, biloba, lobis rotundatis ad 1·8 cm. longis et 2·8 cm. latis, chartacea, supra glabra, subtus in nervorum axillis pubescentia, 7–9-nervia, nervis supra conspicuis subtus prominentibus, reticulatione utrinque gracili, petiolo 1·2–1·7 cm. longo suffulta. *Corymbi* ad 4 cm. longi et 6 cm. diametro; pedicelli 2·4 cm. longi; bracteae 6 mm. longae, bracteolis geminis alternis 3–4 mm. longis. *Calyx* ut pedicelli adpresse pubescens; tubus sulcatus, 5 mm. longus, basi gibbosus; segmenta 6 mm. longa, 2 mm. lata. *Petala* inter se inaequalia, 6–9 mm. longa, 3–5 mm. lata, ungui 2–3·5 mm. longo suffulta, dorso pilosa. *Stamina* 3, filamentis glabris 1 cm. longis, antheris in alabastro 2·5 mm. longis, staminodiis parvis. *Ovarium* 4 mm. altum, suturis ferrugineo-pubescens, circiter 20-ovulatum, stipite 2·5 mm. longo adpresse ferrugineo-pubescente suffultum; stylus 3·5 mm. longus, glaber.

China. Yunnan: Manpan; Red River Valley, 450 m., *Henry* 10,175.

734. **Bauhinia saxatilis**, *Craib* [Leguminosae-Caesalpineae]; a *B. Championii*, Benth. alabastris longius acuminatis, ovario glabro, a *B. Harmsiana*, Hosseus, racemis laxioribus, ovarii stipite glabro distinguenda.

Ramuli graciles, circiter 2 mm. diametro, primo pallide mox ferrugineo- adpresse pubescentes, sulcati. *Folia* ambitu late ovata, oblonga vel subquadrata, basi late cordata vel truncato-cordata, ad 4·8 cm. longa et lata, ad medium vel plerumque paulo ultra medium biloba, lobis divergentibus triangularibus apice obtusis vel rotundatis ad 2·5 cm. longis et 2·4 cm. latis, chartacea, supra primo parcissime adpresse pallide pubescentia, mox ima basi excepta glabra, subtus, inferne praecipue, adpresse pubescentia, plus minusve glabrescentia, 9–nervia, nervis supra conspicuis vel prominulis subtus prominentibus, mediano in apiculum ad 4 mm. longum excurrente, nervulis uti reticulatione supra subprominulis subtus prominulis, petiolo 1–2·8 cm. longo ut ramulis pubescente suffulta; stipulae fugaces, 3 mm. longae. *Racemi* ad 24 cm. longi, breviter pedunculati, pedunculo rhachi pedicellisque ut ramulis pubescentibus; pedicelli sub anthesin graciles, 1 cm. longi, infructescentes conspicue incrassati, 1·3 cm. longi; bracteae deciduae, 4 mm. longae, bracteolis binis alternis circiter pedicelli medium positis ad 3 mm. longis; alabastra acuminata, ad 6·5 mm. longa et 2·5 mm. diametro, adpresse, superne densius, pubescentia. *Calycis* tubus 2 mm. longus; segmenta late lanceolata, acuminata, 6·5 mm. longa, 2 mm. lata. *Petala* alba (ex *Henry*), ad 7·5 mm. (ungui incluso) longa et 2 mm. lata, oblonga, basi in unguem brevem contracta, dorso medio adpresse brunneo-pubescentia. *Stamina* 3, filamentis 8 mm. longis glabris, antheris

in alabastro 2 mm. longis, staminodiis parvis. *Pistillum* glabrum; ovarium 4 mm. altum, 1·5 mm. latum, 7-ovulatum, stipite vix 2 mm. longo suffultum; stylus 4 mm. longus. *Legumen* compressum, apiculatum, ad 7·3 cm. longum et 1·7 cm. latum, brunneum, stipite 3 mm. longo suffultum.

China. Yunnan: plain to north of Mengtze; low shrub trailing over rocks, 1350 m., *Henry* 10,193.

735. **Diospyros Tutcheri**, *Dunn* [Ebenaceae]; species *D. affini*, Thwaites, affinis sed calyce 4-fido distincta.

Arbor parva (?), cortice fusco rugoso; ramuli cito glabri. *Folia* elliptica, ad apicem angustata, acuminata, basi obtusa, 8–12 cm. longa, mox omnino glabra, utrinque reticulata, costis nervisque lateralibus 5–6-paribus supra paullo depressis subtus prominenter elevatis; petioli 0·5–1 cm. longi. *Flores* dioecii; *masculi* in pedunculos racemosos 1–3-mm. dispositi; rachis basi dense sericea, ad 2 cm. longa; pedunculi 3–4 mm. longi; pedicelli 5–6 mm. longi, sparse sericei, prope apicem articulati. *Calyx* 4-partitus, 1–2 mm. longus, lobis patulis triangularibus. *Corolla* urceolata, 7–8 mm. longa, extus dense pallide sericea, intus apice puberula, lobis 4 tubo 8-plo brevioribus reflexis late ovatis. *Stamina* circiter 16, per paria basi breviter dorsi-ventraliter coalita: antherae glabrae, rimis apicalibus brevibus dehiscentes; filamenta breviter hirsuta. *Pistilli* rudimentum parvum hispidum. *Flores foeminei* solitarii, ex axillis foliorium novorum nutantes; pedunculi 1·3–1·5 cm. longi, sericei. *Sepala* 4, 8 mm. longa, ovata, extus sericea, erecta, in fructu paullo elongata, patentia; corolla late urceolata, 5 mm. longa, ore contracto, lobis 4 tubo brevioribus, utrinque tomentella; staminodia 4, linearia, 3 mm. longa. *Ovarium* depresso-globosum, 3 mm. longum, loculis 8, 1-ovulatis. *Fructus* globosus, 2 cm. diametro (nondum maturus), glaber. *Semina* matura non visa.

China. Hongkong Island: Mt. Gough; in watercourses on south side, male and female flowers in March, *Hongkong Herb.* 8218; fruit in October, *Hongkong Herb.* 9995. Both sets were collected by Mr. W. J. Tutcher, Superintendent of the Botanical and Forestry Department, Hongkong.

736. **Chlamydoboea**, *Stapf* [Gesneraceae-Streptocarpeae] gen. nov.; affine *Boeae*, Lam., sed sepalis membranaceis superne dilatatis obtusis in alabastro late imbricatis, corolla suboblique saccato-companulata, filamentis basi sigmatoideo-curvatis anthera longioribus, inflorescentia strobilacea bracteis magis minusve rotundatis amplis munita distinctum.

Calyx 5-sepalus; sepala paulo inaequalia, membranacea, superne dilatata, obtusa, in alabastro late imbricata. *Corollae* tubus brevis, late campanulatus, antice subsaccatus; limbus vix bilabiatus, lobis subaequalibus rotundatis brevibus. *Stamina* 2 antica perfecta, inclusa, supra basin corollae inserta, caetera ad staminodia brevia filiformia redacta; filamenta e basi tenui descendente curvato-erecta, incrassata, intus papillosa; antherae apicibus cohaerentes, loculis inaequalibus, postico majore basi subacuto producto, rimis apice confluentibus. *Discus* annularis. *Ovarium* superum, lineare, ob placentas valde intrusas bifidas imperfecte 4-loculare; stylus brevissimus; stigma 2-lobum; ovula numerosa, margines placentarum revolutas in facie exteriore dense obtegentia. *Capsula*

anguste cylindrica, subuliformis, spiraliter torta, secundum nervos interplacentares dehiscens, basi apiceque haud fissa. *Semina* minuta, oblonga, utrinque minute apiculata.—Herbae *perennes*, *caulescentes*, *tenuiter pannoso-tomentellae*. Folia *opposita*, *petiolata*, *plerumque approximata*. Pedunculi *axillares*. Cymae *multiflorae*, *primo tamen arcte congestae*, *strobilaceae*, *demum paulo solutae*, *bracteis amplis tarde deciduis instructae*. Flores *mediocres*, *roseae vel lilacinae*.

Species unica asiae tropicae orientalis.

C. sinensis, *Stapf*, comb. nov. et descr. emend.

Caulis brevis vel ad 20 cm. altus, ascendens, inferne nudus, cicatricibus foliorum delapsorum obsitus et irregulariter flexuosus nodosusque cinnamomeo-tomentellus. *Foliorum* lamina lanceolato-oblonga, rarius elliptico-oblonga, basi breviter vel longe acuta, apice breviter acuminata, subintegra vel crenulata, 7–13 cm. longa, 3–5 cm. lata, supra primo arachnoideo-lanata, mox glabrescentia, viridia, infra cinnamomea, tenuiter pannoso-tomentella, nervis lateralibus infra prominentibus utrinque 9–12 ; petiolus longitudine varians, ad 6 cm. longus. *Inflorescentiae* sub anthesi ad 3–5 cm. diametro, postea magis minusve solutae ; pedunculi 3–7 cm. longi ; rami subumbellatim vel corymbose dispositi, inaequales, longiores demum ad 2·5 cm. longi ; pedicelli ad 1 cm. longi, uti omnes inflorescentiae axes primo tamen magis minusve araneoso-pilosi ; bracteae infimae saepe connatae, majores ad 2 cm. diametro, omnes inferne vel altius albae, superne viridescentes, apice purpureae, inferne lana detersili instructa, caeterum glabra. *Sepala* spatulata vel spatulato-oblonga, 1–3 cm. longa, superne 4–6 mm. lata, praeter apicem saepe purpurascentem alba. *Corolla*, lobis 5 mm. longis inclusis, 1·6–2 cm. longa, albida, lilacina vel rosea. *Capsula* glabra, circiter 4 cm. longa, 2 mm. diametro. *Phylloboea sinensis*, Oliv. in Hook. Ic. Pl. tab. 1721.

China. Hupeh : Ichang ; on cliffs, *Henry* 1572, 3958, 4158, 6017 ; without exact locality, May, 1900, *Wilson* 854.

Burma. Northern Shan State : Gokteik Gorge, 450 m., *Lace* 4158.

Forma **macrophylla**, *Stapf*. *Caules* ad 90 cm. alti. *Foliorum* laminae 12–27 cm. longae, 4·5–12 cm. latae, ellipticae vel oblongo-ellipticae, rarius late lanceolatae, margine subintegrae, nervis lateralibus utrinque ad 15. *Inflorescentiae* magis compactae, demum minus solutae.

China. Yunnan : Mengtze, on wooded cliffs, 1800 m., *Henry* 11,223A. Szemao, in forests, 1200–1500 m., *Henry* 12,162A, 12,162B, 12305 ; mountain forests, 1800–2100 m., *Hancock*.

Forma **macra**, *Stapf*. *Caules* plerumque humiles. *Foliorum* laminae ad 7 cm. longae, ad 4 cm. latae. *Inflorescentiae* 5–2-florae.

China. Yunnan : Manmei ; south of the Red River, 1800 m., *Henry* 9630 ; Mengtze, 1800 m., *Henry* 9836.

Phylloboea differs from *Chlamydoboea* very considerably in its thinly membranous leaves, peculiar green foliaceous glandular calyx, whose posticous sepals are fused into a trilobed lip, short filaments and straight short capsules which, apart from the subulate style measuring 4 mm. in length, do not exceed 1 cm. The plate representing *Phylloboea amplexicaulis* in Clarke's *Commelynaceae et*

Cyrtandraceae Bengalenses, (tab. 84) shows the capsules twisted, but there is no trace of this condition in Parish's specimens, nor does Parish in his unpublished figure of the plant represent them so. It is true, those capsules had not yet dehisced when collected, but they contain almost mature seeds. In *Chlamydoboea* and *Boea* the twisting sets in at a very early stage of the development of the fruit.

737. **Dichiloboea**, *Stapf* [Gesneraceae-Streptocarpeae], gen. nov.; affine *Phylloboeae*, Benth. et *Boeae*, Lam., ab illa calyce haud foliaceo, inflorescentia, capsulis jam in statu immaturo spiraliter tortis, indumento pannoso-tomentoso distinctum, ab hac sepalis posticis in labium integrum vel breviter 3-lobum connatis, corolla oblique campanulata, stigmate filiformi distinctum.

Calyx 2-labiatus, persistens; sepala 2 antica linearia, libera, 3 postica in labium integrum vel breviter 3-lobum connata. *Corolla* oblique campanulata, more *Digitalis*; limbus vix 2-labiatus, lobis brevibus rotundatis, posticis extimis, antico intimo quam lateralibus minore. *Stamina* antica perfecta, inclusa, prope basin corollae inserta, caetera ad staminodia minuta filiformia redacta; filamenta arcuato-ascendentia, basi haud attenuata; antherae apicibus contiguae, loculis aequalibus divergentibus, rimis apice confluentibus. *Discus* annularis, *Ovarium* superum, lanceolatum vel lineare, ob placentas valde intrusas bifidas imperfecte 4-loculare; stylus brevis, in stigma integrum filiforme vel subliguliforme prorsus curvatum vel flexuosum tota longitudine papillosum productus; ovula numerosa, margines placentarum revolutas in facie exteriore dense obtegentia. *Capsula* subulato-cylindrica, firma, mox spiraliter torta, secundum nervos interplacentares dehiscens, demum saepe apice soluta, valvis binis. *Semina* minute asperula.—Herbae *monocarpicae* (?), *albo-pannosae*. Folia *opposita*, *petiolata*, *lanceolata*, *oblonga vel elliptica*, *crassiuscula*. Inflorescentiae *axillares et terminales*, *pedunculatae*, *sympodiales*, *e racemis spuriis flores geminatos gerentibus vel fasciculis florum inaequaliter pedicellatorum et ramulorum pseudo-racemosorum constituti*. Flores *mediocres*, *coerulei vel albidi*.

Species 2, Asiae tropicae orientalis.

D. speciosa, *Stapf*, comb. nov. et descr. emend.; ab altera specie *D. birmanica*, Stapf (*Boea birmanica*, Craib), foliis supra glabris, bracteis latis, floribus geminatis sessilibus vel subsessilibus majoribus, calycis labio superiore integro, capsulis pannoso-lanatis distinctissimus.

Caulis 30–60 cm. altus, angulatus, tenuissime tomentosus. *Folia* distantia, lanceolata, utrinque acuta, ad 10 (vel teste *Ridley* ad 15 cm.) longa, 2–3 cm. (vel ultra) lata, irregulariter crenulata, supra glabra, subtus albido-pannoso-tomentosa, nervis subtus prominulis utrinque circiter 12; petiolus ad 2–2·5 cm. longus. *Inflorescentiae* racemos spurios paucifloros referentes, floribus geminatis, uno sessili, altero breviter pedicellato, bracteis oppositis late circumdatis; pedunculi ad 7 cm. longi; bracteae late rotundato-ovatae, acutae vel breviter acuminatae, ad 1·5 cm. longae, carnosulae, albido-pannosae; pedicelli longiores, demum ad 5 mm. longi. *Calyx* extus albido-pannosus, intus glaber, circiter 1 cm. longus; sepala libera lanceolato-oblonga; labium superum integrum, naviculare, in

apiculum cucullatum breve productum. *Corolla* coerulea, glabra, 12-15 cm. longa; lobi vix 3 mm. longi, lati, subcrenulati. *Filamenta* 3–4 mm. longa, antheras aequantia. *Ovarium* dense albo-pannosum; stylus cum stigmate flexuoso demum ultra 1 cm. longus. *Capsula* pannosa, ad 1·5 cm. longa, 3·5 mm. diametro, valvis solutis ad 4 mm. latis.—*Phylloboea speciosa*, Ridley in Journ. Linn. Soc. xxxii (1895), 522 et in King and Gamble Mat. Fl. Mal. Penins. 990 (Journ. As. Soc. Beng. lxxiv, ii (1907), 780).

Malay Peninsula. Kedah: Langkawi; common on limestone rocks on the small islands, *Curtis* 2564.

738. **D. birmanica**, *Stapf*, comb. nov. et descr. emend.; a *D. speciosa*, Stapf, foliis supra tomentosis, bracteis angustioribus, floribus in cymarum ramis solitariis vel quum geminatis altero longe pedicellato, corolla minore, calycis labio superiore 3-dentato, capsulis glabris differt.

Caulis ad 40 cm. altus, subangulatus, araneoso-pannosus. *Folia* distantia, oblonga vel elliptica, utrinque acuta, rarius obtusiuscula, basi in petiolum magis minusve anguste decurrentia, minute crenulata, 4–12 cm. longa, 2–6·5 cm. lata, supra tomentosa, subtus albido-pannoso-tomentosa, nervis venisque subtus prominentibus, illis utrinque 7–8; petioli 1–8 cm. longi, illi unius paris basi commissura connexi, aequales vel inaequales. *Inflorescentiae* saepe per totum caulem dispositae, racemos spurios paucifloros plerumque binos cum floribus binis in paniculam vel umbellam spuriam collectos referentes, floribus solitariis vel quum geminatis tunc uno subsessilli altero longe pedicellato, bracteis oppositis circumdatis; pedunculi breves vel ad 5 cm. longi; bracteae oblongae vel ovatae, subacutae vel obtusae, 10–6 mm. longae, 4–3 mm. latae, crassiusculae, supra virides, tomentosae, subtus albido-pannosae; pedicelli longiores, 1–1·5 cm. longi. *Calyx* extus albido-pannosus, intus glaber, 9 mm. longus; sepala libera, sublinearia, obtusa; labium superum apice tridentatum, subnaviculare. *Corolla* alba, glabra, fere 1 cm. longa; lobi 3·5 mm. longi latique, subaequales. *Filamenta* 3–4 mm. longa, antheris paulo longiora. *Ovarium* glabrum; stylus cum stigmate prorsus curvato demum ad 1 cm. longus. *Capsula* glabra, 1·5–2·4 cm. longa, fere 3 mm. diametro, fusco-brunnea.—*Boea birmanica*, Craib in Kew Bull., 1913, 114.

Burma. Maymyo Plateau, 1050 m., *Lace* 5882.

China. Yunnan: Szemao; on cliffs and in forests, 1500–1800 m., *Henry* 12,305 A, 13,112; Puerh, 1500 m., *Henry* 13,396.

739. **Dischidia Micholitzii**, *N. E. Brown* [Asclepiadaceae-Marsdenieae]; affinis *D. acuminatae*, Cost., sed foliis ellipticis vel elliptico-ovatis abrupte acuminatis basi rotundatis, umbellis pedunculatis et coronae lobis bifidis conspicue differt.

Caulis volubilis, gracilis, minutissime et sparse adpresse puberulus, fusco-purpureus, internodiis 2–6 cm. longis. *Ascidia* nulla. *Folia* opposita; petiolus 3–5 mm. longus, 1–5 mm. crassus, puberulus; lamina 2·5–3·8 cm. longa, 1·7–2·7 cm. lata, elliptica vel elliptico-ovata, apice abrupte acuminata, basi rotundata, carnosa, supra plana, subtus leviter convexa, glabra, viridis, plus minusve sordide purpureo-tincta. *Umbellae* axillares, multiflorae. *Pedunculi* 5–8 mm. longi, glabri. *Bracteae* minutissimae, dentiformes. *Pedicelli* 3–3·5 mm. longi, glabri. *Calyx* 5-lobus, glaber; lobi 1·5 mm.

longi, ovati, obtusi. *Corolla* 6-6·5 mm. longa, urceolata, extra glabra, intra fauce barbata; tubus basi ovoideo-inflatus, 3·5 mm. diametro, carneus, purpureo-vittatus; lobi breves, erecti, acuti, virides. *Coronae* lobi erecti, albi, subhyalini, 1 mm. longi, bifidi, lobis incurvo-recurvatis subellipticis obtusis canaliculatis. *Staminum* columna 2 mm. longa, conica, fusco et luteo-variegata, glabra.

Locality unknown, but probably Burma; collected by *Micholitz* and presented by Messrs. F. Sander & Sons in 1913 to Kew, where it flowered on May 14th.

740. **Rhodospatha Forgeti**, *N. E. Brown* [Aroideae - Calleae]; affinis *R. costaricensi*, Engl., sed vagina petioli integra, spatha et spadice multo longiore, spadice tenuiore breviter stipitato, ovario multo breviore differt.

Caulis scandens. *Folia* patula, glabra; petiolus circa 30 cm. longus, ad geniculum vaginatus, marginibus vaginae integris; lamina 40–50 cm. longa, 14–15 cm. lata, oblongo-lanceolata, apice subabrupte angustata et breviter cuspidato-acuminata, basi late cuneata, supra viridis, subtus subflavo-virens, venis primariis lateralibus 30–32 supra impressis subtus prominentibus. *Pedunculus* circa 15 cm. longus, 1 cm. crassus, pallide viridis. *Spatha* 15 cm. longa, 9–10 cm. (explanata) lata, late elliptica, extra sordide pallide-roseo-alba, intra sordide rosacea. *Spadix* 12 cm. longus, 1·4 cm. crassus, cylindricus, obtusus, stipite 4–5 mm. longo et 8–9 mm. crasso suffultus, pallide rosaceus. *Ovaria* 3 mm. longa, apice 2·5 mm. lata, 4–5-angulata, truncata, stigmate atro-fusco anguste oblongo coronata; loculis multiovulatis.

Costa Rica. Without precise locality, *Forget*.

Described from a living specimen communicated by Messrs. F. Sander & Sons of St. Albans, who received the plant from Mr. Forget whilst collecting for them in Costa Rica.

LVII.—MISCELLANEOUS NOTES.

Mr. George Bryce, M.A., B.Sc., of the University of Edinburgh, has been appointed by the Secretary of State for the Colonies, on the recommendation of Kew, Assistant Mycologist and Botanist in the Department of Agriculture, Ceylon.

Mr. Godfrey E. Coombs, B.Sc., of University College, Reading, has been appointed by the Secretary of State for the Colonies, on the recommendation of Kew, Economic Botanist in the Department of Agriculture of the Federated Malay States.

Mr. F. T. Brooks, M.A., Senior Demonstrator in Botany in the University of Cambridge, has been appointed by the Secretary of State for the Colonies, Mycologist in the Department of Agriculture of the Federated Malay States for one year.

We learn that Mr. W. Nowell, Assistant Superintendent of Agriculture in Barbados, has been appointed by the Secretary of State for the Colonies, Mycologist and Agricultural Lecturer in the Imperial Department of Agriculture for the West Indies, in succession to Mr. F. W. South (*K.B.*, 1913, p. 125).

Mr. Frank Gordon Walsingham, a member of the gardening staff of the Royal Botanic Gardens, has been appointed, on the recommendation of Kew, Assistant Director of Horticulture in the Egyptian Department of Agriculture.

Osmunda from St. Petersburg.—Kew is highly indebted to the Director of the Imperial Botanic Garden of Peter the Great, St. Petersburg, for a remarkably fine specimen of the Royal Fern, *Osmunda regalis*, L. The specimen presented to Kew is one of several obtained from near Adler in the Sotshi district of the Caucasus, which are among the glories of the St. Petersburg Garden. An illustration of one of these plants, very similar in size to the one now at Kew, was given in *K.B.*, 1913, p. 249.

The following note by Prof. Fischer de Waldheim in Bull. Jard. Imp. Petersburg, iv., 1904, p. 69, gives interesting particulars about one of these remarkable ferns.—"Towards the end of 1903 the Garden received a very precious gift from M. Scriwanek, a living example of a plant of *Osmunda regalis*, L., more than a thousand years old. It was found in a forest near Adler in the Caucasus on the shores of the Black Sea. The trunk above the surface of the soil is nearly three metres in circumference, half a metre high and carries fourteen more or less strong branches nearly 35 cm. in length. The branches have produced leaves of extraordinary vigour."

The plant presented has a large, massive, woody rootstock, with a circumference of 5 feet at the base, rising to a height of 2 feet 6 inches which has branched into eight distinct stems, with ten separate crowns, all of them furnished with strong fibrous rootlets. The stems extend horizontally, thus giving the plant a breadth of 3 feet 2 inches. At present the plant is without fronds as these have been cut off for convenience of packing.

These remarkable Osmundas more nearly resemble in general appearance old specimens of *Todea barbara* than any other fern, and since the two genera are nearly allied it may be of interest to compare the dimensions of the *Osmunda* with the large plant of *Todea* now growing in the Temperate House.

The *Todea* has a breadth of 3 feet 6 inches at the base, and is 2 feet in height, with eighteen crowns, while many of the fronds are 8 feet in length.

W. T.

Presentation of Orchids.—The Kew collection of orchids has been enriched by the presentation of a valuable collection of healthy, well-grown plants by Mrs. Sheppee, of Holly Spring, Bracknell.

These orchids represent a portion of the collection formed by the late Colonel Sheppee, an orchid enthusiast of no mean order. Upwards of 260 plants have been received, many of them being handsome specimens, and among the rarer species there are some which were not represented at Kew. Of the more interesting of these may be mentioned *Dendrobium sanguineolentum* var. *album*, *Zygosepalum rostratum* and *Arundina bambusaefolia*. The collection includes 26 species of *Dendrobium* and a number of the best hybrids. The specimens of *Angraecum eburneum*, *A. Leonis*, *A. sesquipedale*, *Peristeria elata* and *Vanda Sanderiana*, and a fine healthy specimen of *Cyrtopodium punctatum* are particularly worthy of notice. Other genera represented in the collection by one or more species are *Masdevallia*, *Miltonia*, *Lycaste*, *Thunia*, *Zygopetalum*, *Anguloa*, *Catasetum*, *Coelogyne*, *Cattleya*, *Laelia*, *Phalaenopsis* and *Trichopilia*.

C. P. R.

Bust of Sir J. D. Hooker.—On 14 July, 1913, Lady Hooker addressed the following letter to the Director :—"May I ask your "acceptance on behalf of the Royal Botanic Gardens, of a Bust of "my late husband Sir Joseph Dalton Hooker? The clay model was "taken from life by Mr. Pennacchini, in the autumn of 1911; "from this a marble bust has lately been completed and it may, I "hope, find an appropriate place in the Institution at Kew, to the "interests of which he devoted the best years of his life."

Lady Hooker very kindly accepted an invitation to pay a visit to Kew with a view to the selection of the most appropriate position for the bust. The spot decided upon is in Museum No. I, where there already is a bust, by Thomas Woolner, R.A., of Sir W. J. Hooker, father of Sir J. D. Hooker and predecessor of Sir Joseph in the post of Director of Kew.

In accordance with an undertaking entered into at the time of this visit the bust of Sir Joseph Hooker was conveyed to Kew by the artist himself and placed in the position decided upon, under his supervision, on 12 August, 1913.

Index Kewensis, Supplement IV.*—The appearance of the fourth supplement to the Index Kewensis continues that work to the end of the year 1910. Compared with the two preceding quinquennial supplements, the one just issued exhibits a notable increase in size, containing 252 pages as against 204 and 193 respectively in the second and third supplements. The plan of the work remains the same with a few exceptions. The most important difference is that the present supplement is now a register of names without any reductions, no opinion being expressed as to the validity of the genera and species included in it. The genera are referred to the

* Index Kewensis Plantarum Phanerogamarum Supplementum Quartum, nomina et synonyma omnium generum et specierum ab initio anni MDCCCCVI usque ad finem anni MDCCCCX nonnulla etiam antea edita complectens, ducta et consilio D. Prain confecerunt Herbarii Horti Regii Botanici Kewensis Curatores. Oxonii, e prelo Clarendoniano. MDCCCCXIII.

families to which they were assigned in de Dalla Torre et Harms, Genera Siphonogamarum, the name of the family according to Bentham and Hooker's Genera Plantarum being added where different. The geographical distribution of new species is stated, but in the case of new combinations only the synonym is given. Numerous names accidentally omitted from previous supplements are included, and others are re-inserted in cases where the reference originally given was not the earliest.

T. A. S.

Botanical Magazine for November.—The plants figured are *Alocasia Micholitziana*, Sander (t. 8522); *Rhododendron setosum*, D. Don (t. 8523); *Senecio Kirkii*, Hook. f. (t. 8524): *Coriaria terminalis*, Hemsl. (t. 8525) and *Streptocarpus orientalis*, Craib (t. 8526).

Alocasia Micholitziana is a near ally of the well-known *A. Sanderiana*, Bull, but may be easily distinguished from that species by its smaller very rarely peltate leaves, which are less deeply lobed at the margins and are of a deeper and very different shade of green, without silvery borders to the almost straight primary lateral veins. It is a native of the Island of Luzon, Philippines, where it was first discovered by Mr. A. Loher. Its introduction to cultivation was effected by Mr. Micholitz about three years ago, when collecting on behalf of Messrs. Sander & Sons, of St. Albans.

Rhododendron setosum is a neat-growing species, only about one foot high, with small rather sparingly lepidote leaves and clusters of rose-purple flowers about ¾-inch long. The corolla is 5-lobed to within ⅓-inch of the base. It is a native of the rocky slopes of the loftier passes leading across the Eastern Himalaya into Tibet, and is remarkable for the heavy resinous aroma which it exhales after hot sunshine. The species is rarely met with in gardens, apparently being short-lived. The material for the illustration was obtained from Sir Edmund Loder's garden at Leonardslee, Horsham.

Senecio Kirkii is endemic in the North Island of New Zealand, where it occurs from sea-level to an elevation of 2500 feet, and is one of the many interesting plants introduced into this country from New Zealand and the neighbouring islands by Capt. A. A. Dorrien-Smith. It is a shrubby species, 7–15 feet high, with linear-oblanceolate or obovate leaves, and large corymbs, sometimes as much as 3 feet across, of white flower-heads, 1½–2 inches in diameter. The plant flourishes in Mr. T. A. Dorrien-Smith's gardens at Tresco Abbey, Isles of Scilly, whence material for the figure was obtained.

Coriaria terminalis, a native of China, Tibet and Sikkim, is a sparingly branched shrub, with opposite entire ovate leaves and long terminal racemes of insignificant flowers, which are followed by very ornamental orange-yellow 'fruits'—the fleshy petals—about ¼-inch long. The material for the figure was contributed by Canon Ellacombe, in whose garden at Bitton, near Bristol, *C. terminalis* and other species of the genus grow vigorously.

Streptocarpus orientalis is interesting as being the only Asiatic representative of a genus hitherto supposed to be limited to Africa south of the Tropic of Cancer and to the Mascarene Islands. It

was originally described about two years ago from material which was included in the rich collections made by Dr. A. F. G. Kerr, near Chiengmai, Siam. Seeds were sent to Kew by Dr. Kerr in 1912, and from these the plant now figured was raised. The species is caulescent, with membranous ovate or elliptic-ovate leaves 1–3½ inches long, and a racemose cyme, ultimately 10 or 12 inches long, of purple flowers.

A New Work on Conifers.*—We have received a copy of this excellent and profusely illustrated work, recently published under the editorship of Count Ernst Silva Tarouca and Dr. Camillo Schneider, President and Secretary respectively of the Dendrological Society of Austria-Hungary. There is scarcely a page without an illustration, many pages have two, and the attractiveness of the volume for the general public is enhanced by twelve reproductions of photographs in colour. There are also six folded plates devoted to the delineation in black and white of cones, chiefly those of *Pinus*, *Abies* and *Picea*. The usefulness of the volume for purposes of identification is increased by numerous engravings of leaves, leaf-sections, buds, cone-scales, etc. On the whole it is probably the most comprehensively illustrated volume on conifers in existence. The pinetum of Mr. G. Allard (*K.B.*, 1913, p. 316) has supplied a large number of subjects for illustration, and the Vilmorin collections at Verrières and Les Barres in France, and the Royal Gardens at Sans Souci and Dresden, as well as Mr. Hesse's nursery at Weener, have supplied the editors with much foreign material for illustration. The unrivalled pinetums in the British Isles possess much finer examples than many published in this volume, but for a work in German and intended primarily for Austrian and German use, a series of pictures taken in Central Europe is, no doubt, of more interest and value than those would be made in our milder insular climate.

The first part of the work is devoted to a general discussion of the family. The editors deal with the landscape value of conifers in park and garden; Mr. E. H. Wilson writes of Chinese conifers; Mr. A. Rehder on North American ones. Cultivation and propagation are discussed by Mr. Franz Zeman.

The second part is devoted to an analytical key of the whole family, followed by descriptive notes on species and their varieties. The genera are alphabetically arranged, but the species and varieties follow each other according to relationship. To students acquainted with the German language, this volume supplies a mass of condensed information of the greatest value respecting one of the most important and fascinating families in the Vegetable Kingdom.

W. J. B.

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* Unsere Freiland-Nadelhölzer. Vienna, F. Tempsky; Leipsic, G. Freytag. With 14 coloured plates, numerous half-tone reproductions of photographs and engravings.

Marram Grass for Paper-making.—A note appeared in *K.B.*, 1912, p. 396, directing attention to the value of Marram grass (*Ammophila arundinacea*, Host.), for the manufacture of paper, with the results of certain experiments carried out by Messrs. Clayton Beadle and Stevens.

A further series of experiments have been conducted by the same firm, the results of which are appended.

Messrs. Clayton Beadle and Stevens write :—"We have extended our experiments in the direction of the utilisation of the above fibre [Marram grass] for the purpose of paper-making and the following are the results obtained :—

"On green stem as received—

Yield of dry uncrushed fibre	56·4	per cent.
Yield of boiled unbleached (bone dry) fibre	17·7	„
„ „ „ bleached „ „ „	13·1	„
Percentage of ash	2·08	„
Soda consumption (NaOH)	6·85	„
Bleach consumption (bleaching powder)	2·03	„

"On dry stem—

Yield of boiled unbleached fibre ...	31·4	„
„ „ „ „ (bone dry) fibre	25·0	„
Soda consumption (NaOH)	12·2	„
Bleach consumption (bleaching powder)	3·62	„
Ash of dry stem	3·70	„
Length of fibre (mean of 10 observations)	0·65	mm.

"The grass was boiled for 6½ hours at 50 lb. pressure in a stationary boiler. In our opinion, the ordinary type of vomiting boiler, as used for the treatment of esparto, would be suitable for the purpose of treating this grass. The grass goes down readily under the treatment of the caustic soda. It yields a product of fair unbleached colour. We tested the bursting strain of paper made from the unbleached fibre with substance of about 16 lb. Demy, bursting strain 27 lb. to the sq. in., substance of about 21 lb. Demy, bursting strain 33 lb. to the sq. in. The fibres possess good felting qualities ; the paper is harder in the unbleached state than in the bleached. It has every appearance of possessing similar qualities to those of esparto. In spite of the extreme shortness of the fibres, as will be seen above, it possesses considerable strength, combined with qualities which appear to render it suitable for fine printings. Although the fibres are shorter than those recorded for esparto, the paper appears to possess greater strength. The yield is somewhat low and the consumption of soda is somewhat high in comparison with esparto.

"Having regard to the rapidity of growth of this grass in many parts of the British Isles, and the possibility of extending its growth on waste lands from whence it might be got into the mills at a low figure, we think paper-makers should turn their attention to the possibility of its utilisation, particularly having regard to the very promising nature of its paper-making qualities.

"Although the soda consumption is high, the fact must not be lost sight of that 80–90 per cent. of the soda in such a case would be

recovered and used over again. The actual cost of chemicals for boiling is therefore a matter of the cost of recovery plus the cost of making good the soda lost during the process."

Messrs. Clayton Beadle and Stevens remark that the paper-maker wants some assurance upon the subject of adequate supplies before he is disposed to try a material of this sort on an extensive scale, for he knows perfectly well that there are many fibres from which he could make paper provided they can be obtained in sufficient quantity to make the enterprise a financial success. The paper-maker therefore is naturally not disposed to exploit any particular material until he sees a chance of getting large and regular supplies of it at a low cost.

Marram grass occurs on most of the sandy shores of the British coast-line. In some places it is limited to occasional tufts but as a rule it is distributed irregularly over a considerable area. Patches of from a few plants to stretches 20 or 30 yards across are found with moderately wide, bare intervals, the smaller patches being often buried to a considerable depth in loose sand. This would appear to make economical harvesting almost impossible and if steps are to be taken to collect the material in bulk, certain areas should be set apart in Norfolk or Lincolnshire for experimental purposes. By selecting positions where the grass is already plentiful and using the existing stock for close planting of an area of about five acres, it would be possible to harvest a full crop at the end of the second year which could be made the basis for deciding whether the crop is likely to be profitable or not. When growing in a dense mass it is unlikely that the leaves of any except those of the outer plants would become buried in sand, and clean leaves would lessen materially the cost of harvesting. An area of five acres could be planted at a small cost, for the ground would need no preliminary preparation and two men would, in a few days, be able to divide up sufficient plants, and plant the area with clumps three feet apart.

Providing it proved to be a paying crop, Marram grass might be planted on any sandy area along the coast. Suitable sites are to be found in Dorsetshire, Kent, Norfolk, Lincolnshire, Lancashire, South Wales, Scotland and elsewhere.

There is no reason to doubt the ability of the plant to withstand the repeated cutting of the leaves, for although this grass was introduced into New South Wales as recently as 1883 the inhabitants have for many years pastured their cattle upon the young leaves. An account of its introduction into New South Wales by Baron von Mueller, together with a detailed description of its culture and behaviour in that country, is given in *K. B.*, 1897, pp. 211–217. From this article we learn that although originally introduced for the purpose of binding sand, it had by 1893 become acknowledged as an important fodder grass, cattle being turned into Marram grass enclosures during the early rains of April and allowed to remain there until the advent of the dry season.

Marram grass is also grown largely on the west coast of France for the purpose of fixing the sand prior to afforestation and if it were planted in dense masses it would be possible to obtain a large yield from that region alone. Similar possibilities are afforded by

the coast line of Holland, Belgium, Germany and N. Africa. Various references to its use in Germany for fixing sand and checking coast erosion are to be found in "Handbuch des deutschen Dünenbaues," by Paul Gerhardt and others ; pages 344–414 being devoted largely to the cultivation of this and allied species. A series of illustrations indicate the windswept and barren areas of sand where the grass flourishes, and also the methods of planting and general cultivation which are encouraged.

Whilst the preceding notes were in press a communication was received from Mr. O. R. Evans, Town Clerk to the Borough of Port Fairy, Victoria, to the effect that his attention had been directed to the note on "Marram Grass for Paper Making," which appeared in *K.B.*, 1912, p. 396. In asking for further information he added :—"This question is a very important one to this borough. The council has under its control miles of coast line planted with Marram grass, and the facilities are available for the establishment of an industry, should it be practically demonstrated that paper could be profitably manufactured from Marram grass."

Mr. Evans also furnished information regarding the introduction, cultivation, and growth of Marram grass in the neighbourhood of Port Fairy, the following being the salient points :—

The grass was originally introduced into the Colony of Victoria in 1883 by Baron von Mueller, seeds being sent to the Borough Council of Port Fairy to test on the then troublous, barren, shifting sand hummocks facing the shores. Great care was taken in raising the first young plants and the results have been far-reaching, for miles of sand dunes, on both the eastern and southern shores, have been entirely reclaimed in such a complete manner that, where for years nothing but shifting sand prevailed, there is now an area of magnificent grass, growing as thick as a cornfield and to a height of four feet. The grass is said to be practically indestructible, burning, cutting, or eating-off by cattle making it thrive, and in most exposed shifting sands it grows as strongly as in a sheltered corner. The plantations are under the control of Mr. S. T. Avery, and they are formed by dividing the clumps into sections as large as a man can conveniently grasp, and planting them two feet apart in rows six feet apart. Where the sand is not likely to shift, the roots are buried to a depth of nine inches, but where shifting sand is encountered they are buried from three to six inches deeper. In this way 3630 plants are placed on an acre of ground, 2800 plants weighing a ton. The most favourable time for planting is from early May to the end of July, and at the end of a year thinning and transplanting is carried out if plants are required elsewhere. Grass from the Port Fairy district has been supplied to the Governments of the five Australian Colonies, New Zealand, Tasmania, Cape Colony, India, and Brazil for planting in the loose sand of the coast regions, and in each case it is said to be thriving satisfactorily. Grass exported in this manner is dug, packed, and carted to wharf or railway station at a cost of about 50*s.* a ton.

From what can be learnt of the condition of Marram grass in the Port Fairy district, it is reasonable to conclude that the Borough Council would be well advised to enter into negotiations with some

firm of paper manufacturers for the purpose of testing the value of the grass when supplied in considerable bulk. The results of such tests would be watched with considerable interest not only by Australians but by Europeans of many nationalities.

W. D.

Planting in Uganda.*—The book is the outcome of the authors' experience of plantation work in Uganda, and has been written for the guidance of planters who may now be settling in Uganda, and who are bound to suffer from lack of knowledge of the peculiar conditions under which plantations have to be worked in that region.

The physical features of the country are described and photographs are reproduced showing the types of country suitable for plantations. Other photographs show the crops in the various stages of development, and the history of their introduction is given.

Para rubber and cocoa were first experimented on with plants received from Kew in 1901, and it is pleasing to learn that the whole of the cocoa now grown in Uganda has come from these young plants and their progeny.

Chapter iii is devoted to "Yields and Results," and some of these are very striking. For example, coffee produces a "maiden" crop in 2½ years from the time of sowing, and a full crop is obtained at 3 years, which is 2 years in advance of Ceylon, where 5 years are necessary before a full yield is obtained. Two crops are borne annually, and the product is considered in London to be of "high grade," and the prices obtained are said to be entirely satisfactory.

Advice is given as to the selection of suitable land for planting, the establishment of nurseries, laying out of plantations and their management, useful shade- and cover-plants for preventing denudation by the rains, and the methods of clearing and planting in considerable detail, with numerous excellent illustrations of the methods followed.

The most common weeds and their root-systems are described and illustrated, together with advice as to their eradication.

Other chapters are devoted to the erection of factories and machinery, collection and preparation of the crops, the direction of labour, the cost of establishment of plantations and the preparation of products.

There is also a chapter by Mr. G. Massee on diseases caused by fungi.

J. H.

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* Planting in Uganda. By E. Brown, F.L.S., and H. H. Hunter, LLD. London : Longmans, Green & Co. ; Dublin : The Talbot Press : 1913 ; 176 pp., 41 illustrations and 2 maps.